TERRA

THE NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY
VOL. 22, NO. 6 · JULY/AUGUST 1984

FROM THE DIRECTOR

Dr. Craig C. Black

Los Angeles is a city that thrives on diversity, on size and complexity, on the spotlight and center stage. All of this is now upon us to an extent probably unprecedented in our history. The Summer Olympic Games are taking over Los Angeles, and for the next several weeks we will host visitors from around the world, our population will swell, and there will be an influx of reporters and sportscasters that will place Los Angeles truly on the world's center stage.

The Natural History Museum occupies a unique place in the midst of all this activity. The greatest single concentration of Olympic events will be played out in Exposition Park where we may expect 200,000 or more visitors, athletes, and reporters each and every day during the Games. The main attractions will, of course, be the events in the Coliseum, the Sports Arena, the Swimming Stadium, and the Olympic Village at the University of Southern California. However, as you read in the last issue of TERRA, the museum will also have much to offer to Olympic visitors. We wrote then of three special exhibitions prepared for the Olympic Arts Festival, all related to Los Angeles history, with objects taken from the museum's extensive history collections.

We now know that the museum will be presenting a very special exhibition loaned to us by the Greek Government and taken from the unique and irreplaceable collection of the Museum at Mount Olympus. This exhibition dealing with the Ancient Olympics, with pieces from the 6th to 8th Century B.C. Games, will open in mid-July and will be on view in the museum's Rotunda through mid-September. The exhibition curator, Madame Romiopoulou of the National Museum in Athens, has masterfully blended objects from the Ancient Games with photographs of the original Olympic stadium and other graphics and text, to provide a unique view of the earliest Games and a fine counterpoint to the museum's exhibition on the 1932 Olympiad held in Los Angeles. We are extremely happy to be able to present this exhibition and are indebted to the Greek Government for allowing these priceless pieces to travel to Los Angeles for this occasion.

All of the museum's Olympic Art Festival exhibitions will remain on view after the close of the Games themselves. This will ensure that our members and all those in the Los Angeles area who do not have tickets for the events in the Exposition Park venues, or who chose to avoid the hubbub of the Park during the Games themselves, still have an opportunity to see these very special exhibitions.

Our visitors often have problems finding parking at times during the year when a major event is scheduled in the Coliseum, and these problems will be even more acute between mid-July and mid-August. We suggest that members of the museum who are not coming to Olympic events during this period either see the museum's Olympic exhibitions before the Games begin or postpone your visit until after August 15th.

CRAIG C. BLACK
Director

CURATORS & COLLECTIONS

SUBJECT INDEX FOR TERRA MAGAZINE, VOLUME 22

A comprehensive index to Volume 22 of TERRA, the first to be prepared for the magazine, is now available through the Publications Office at the Natural History Museum. Please call 213/744-3330 if you would like to receive a copy.

NEW HERPETOLOGY FACILITY

The Herpetology Section has recently occupied newly constructed quarters in the museum. In addition to two movable shelving systems (compactors) that house the research collections and library, the 4,000-square-foot facility includes curatorial and data-filing offices and chromosomal, biochemical, and preparation laboratories. The renovations were jointly funded by the museum's Foundation, the County of Los Angeles, and the National Science Foundation. The compactors were purchased with funds from a National Science Foundation grant, the second award that has been made to the Section in recognition of its increasing importance as a national center for herpetology. Although the construction phase of the project is now completed, sufficient funds have not been available to fully equip the facility, but they are being sought.

(Continued on page 31)

TERRA

THE MEMBERS' MAGAZINE
OF THE NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY
AND THE PAGE MUSEUM
OF LA BREA DISCOVERIES

VOL. 22, NO. 6 · JULY/AUGUST 1984

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Red-breasted Merganser, *Mergus serrator.* Watercolor study by Louis Agassiz Fuertes. Courtesy of the American Museum of Natural History.

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Six Artists in Search of a Medium

The six illustrations of woodpeckers shown on pages 4 and 5 were created over a 150-year period and represent benchmarks in style, exclamation points in the history of natural science illutration and art. Suffice it to say, five of the artists, Mark Catesby, Alexander Wilson, John James LaForest Audubon, John Gould, and Louis Agassiz Fuertes, are deservedly well known today; their biological illustration has endured because of its beauty as art. Each artist was in the vanguard of his discipline during his time, and it little matters that each may seem to have been surpassed by some who came after. The sixth artist, the Spaniard José Cardero, and his contemporaries are not as familiar to us yet, but that is an accident of politics, a vagary of the unsettled times in which they worked. Had the paintings of the Spanish natural history illustrators of the late eighteenth century been published, their renown would have been equal.

As one studies the six prints and paintings and compares them, it is obvious that some important changes have taken place. Observe. Look closely. What you are seeing is an evolution of style, artistic skill, and technique on the part of the artists and of critical appraisal on the part of their audience. All of the six artists had innate talent but the products of the earlier artists were, perhaps, not as critically evaluated as were the works of the later artists. The viewers of the early paintings were pleased and uncritical because these images of flora and fauna—the first that they might have seen—opened vistas on the natural world.

The ultimate goal of these artists was the dissemination of visual information in printed books. In the late eighteenth and early nineteenth centuries, the primary means of reproducing book art were various intaglio processes such as copperplate engraving and etching. For the artists of that time, an original work, be it a finished painting or a sketch, was just the beginning. The image was then to be engraved on a copperplate by a skilled engraver. If color was required, a third or perhaps even a fourth person applied it. Thus, there were often two or three craftsmen involved in transmitting the original art to its elite audience, the book buying public.

The works of Mark Catesby (1679?–1749) and Alexander Wilson (1766–1813) are very similar in their look, characterized by a certain stiffness of pose and, we think, a certain naiveté. This may be explained partly by the lack of a critical audience and partly by the very formal demands of copperplate engraving. The Cardero, a watercolor, has the same unsophisticated, stiff look. One might speculate that Cardero had the engravers in mind when he drew the flicker shown here. His work might be a case of art bending to reproduction technique.

John James LaForest Audubon (1770–1851) had a vision. He wanted to show his birds life size and in the proper habitat. For this reason he chose to have his paintings reproduced on the extravagant double elephant sized paper (27 by 40 inches). Several intaglio processes were used to reproduce his watercolors: aquatinting, etching, and perhaps some engraving. Audubon, although not an engraver, was a perfectionist, and he provided a certain quality control for his prints and was especially critical of the coloring. He wanted his birds to be lifelike, and although they may seem contrived to us, they were more realistic than anything seen hithertofore, and he was hailed as a great artist and naturalist by his audience. The work was impressively large, filled with birds and plants of vibrant color, and reproduced using sophisticated techniques that were quite true to Audubon's originals.

Soon after the beginning of the nineteenth century, Aloys Senefelder discovered lithography, a planographic printing technique based on the antipathy of grease and water. Lithography allowed for fluidity of design—almost anything that could be drawn on paper could be drawn on stone. The artist could work directly on the stone (originally limestone); prints could then be pulled indefinitely (the stone with its greasy image did not break down after successive uses as did the copperplate). As the nineteenth century advanced, the skill of the artists became more sophisticated, and the techniques used to reproduce their work changed and placed fewer obstacles in the way of its creation. Few natural history artists did their own engraving, but many could do their own lithography, drawing their images directly onto the stone.

John Gould (1804–1881), one of the leading British ornithologists of his time, used lithography to produce more than 40 large folios, containing over 3,000 plates. He collaborated with a series of skilled artists including his wife Elizabeth Gould, who reproduced many of his sketches on stone. Once printed, the images were subsequently hand colored. Gould, with his cadre of sophisticated bird artists, took full advantage of the technique of lithography and provided his relatively sophisticated audience with lively images of birds. The artists of the eighteenth and early nineteenth centuries paved the way for Audubon, who revolutionized natural history art. Audubon in turn provided a standard for John Gould. Fuertes' work may be called the culmination of an era. His talent and training, his field knowledge of birds, and the sophisticated photographic techniques available for reproducing his art in color converged to create beautiful, glowing images of birds and animals in books and magazines for many to enjoy.

Two articles in this issue of Terra highlight the drama of the evolution of biological illustration. Robert Peck writes of the life of Fuertes, whose glorious illustrations of birds will grace the museum's halls this summer. Fuertes' struggle to accommodate his two mentors—one an artist and the other an ornithologist—made his paintings unique in their beauty as well as their perspective on nature. Iris Engstand tells of the lives of several artists who accompanied expeditions to Spanish territories in the New World in the 1780s. Only now, almost 200 years later, are the illustrations that they produced finally beginning to appear in print. It is ironic that these drawings, which would have been reproduced by copperplate engraving, are being reproduced in color for the first time with ease, using twentieth-century photomechanical processes that would have astounded the artists.

KATHARINE E. S. DONAHUE
Museum Librarian

Below:
Red-headed Woodpecker, by Mark Catesby. From The Natural History of Carolina, Florida, and the Bahama Islands....*1771, 2 volumes, large folio. Courtesy of the Hancock Library of Biology and Oceanography.*

Mark Woods

Dick Meier

Red-headed Woodpecker, Yellow-bellied Woodpecker, Hairy Woodpecker, and Downy Woodpecker, by Alexander Wilson. From American Ornithology; or the Natural History of the Birds of the United States....*1808–1814, 9 volumes, folio.*

Red-shafted flicker, Colaptes cafer, *by José Cardero. Illustration made on the Malaspina Expedition, 1789–1794. Courtesy of the Museo Naval, Madrid.*

Dick Meier

John DeLeon

Top left: Red-headed Woodpecker, Pincus erythrocephalus, *by John James LaForest Audubon. From* The Birds of America. *1827–1838, 4 volumes, double elephant folio.*

Bottom left: Lesser Spotted Woodpecker, Picus minor, *by John Gould. From* The Birds of Europe. *1832–1837, 5 volumes, large folio. Courtesy of the Hancock Library of Biology and Oceanography.*

Bottom right: Red-headed Woodpecker, Melanerpes erythrocephalus, *by Louis Agassiz Fuertes. Courtesy of the Academy of Natural Sciences, Philadelphia.*

Bringing Birds to Life

THE LIFE AND ART OF LOUIS AGASSIZ FUERTES

by ROBERT McCRACKEN PECK

To knowledgeable bird-watchers the world over, the name of Louis Agassiz Fuertes has long been synonymous with great bird painting. From the time of his first publication in the 1890s until Roger Tory Peterson's *Field Guide to the Birds* became the standard reference of field identification a half century later, Fuertes' colored plates were as central to American ornithology as binoculars and bird seed. Generations of Fuertes' admirers learned to tell bluebirds from bobolinks, robins from rails, by poring through the hundreds of books and magazines he illustrated. To some, Fuertes' images became more real than the birds they depicted. As Peterson himself observed in 1942, the average bird-watcher of the period would often see a bird "as Fuertes drew it, not as it actually looked in the brief moment it perched before him." In looking at Fuertes' paintings today, we can understand why. Surely few painters have ever made the birds of the world so lively, appealing, and memorable.

In the success of his balance between scientific accuracy and attractive aesthetic design, Fuertes' contribution stands almost alone in the crowded field of wildlife art. "Of those who have gone before," observes Roger Tory Peterson, "we can be sure of only two who will be remembered far into the future: Audubon, who took birds out of the glass case for all time, and Fuertes, who really brought them to life."

Fuertes attributed his remarkable success at bird painting to hard work and "accurate seeing." In a letter to one of many young artists who sought his advice, Fuertes commented on the importance of resisting artistic convention in favor of first-hand observations from life. It was a practice he followed throughout his career:

> Painting is *easy* after you've learned sight, and a painter's greatness is far less dependent on his ability to handle paints and brushes than on this ability to rightly see the truth. Probably the hardest thing of all, at first, is to get rid of prejudices—or mental habits, to the effect that because a pine tree for instance, is *known* to be blue-green it always looks that way, regardless of lighting conditions. Get out of the notion that black is always black—or that any other color is always true to its name. Colors have no such loyalty, and if something you know is green looks violet, don't be afraid to so paint it. Be honest with yourself—go ahead—your mistakes will teach you more than your success if you have the honesty and courage to *use* them and not discard them as failures. It is through study that they are not repeated: success *may* be largely luck, whose elements are unrecorded and consequently not available next time you need them.

Fuertes found East Africa an ornithologist's paradise and an artist's dream when he traveled there in 1926. On Mt. Albasso he was able to capture a live Lammergeier of which he made several fine drawings and a watercolor study. Courtesy of Cornell University Department of Manuscripts and Archives.

Named after, but unrelated to, the great nineteenth century naturalist Louis Agassiz, Fuertes was the youngest in a family of six, born to Mary and Estevan Fuertes of Ithaca, New York in 1874. His father, a native of Puerto Rico, was a professor of civil engineering at Cornell University at the time of Louis's birth. Later he would become dean of the engineering school at the university. Louis's mother was a talented amateur musician. Neither parent had an inordinate interest in birds; this was something Louis developed on his own, and at a very early age.

By the time Fuertes entered Cornell as an undergraduate in 1893, he had already earned a wide local reputation for his keen abilities of observation, his knowledge of birds, and his ability to capture their appearance on paper. He had received no formal instruction in art or ornithology except through gleanings from the work of his predecessors in the field. Of these, Alexander Wilson and John James Audubon left the greatest impression on the young artist. Many of his early works reflect compositions de-

rived in spirit—although never copied directly—from Audubon. His was "the most potent influence that was ever exerted upon my youthful longing to do justice to the singular beauty of birds" acknowledged Fuertes in later years.

The history of art is filled with tragic stories of talented artists where genius was recognized posthumously or so late in the artist's lifetime as to provide little comfort, encouragement, or financial reward. Fuertes' experience was quite the opposite. By the time he was twenty-one, his work had been seen, recognized, and shared with a wide circle of influential patrons by the foremost American ornithologist of the day, Dr. Elliott Coues (1842–1899).

Coues's promotion of Fuertes' work with the scientific community resulted in a series of commissions that launched Fuertes' career as a professional painter of birds before he had even graduated from college. A series of pen-and-ink drawings for Florence A. Merriam's *Birding on a Bronco* (1896); four plates for *The Osprey*, a new ornithological magazine (1897); and 111 illustrations for Elliott Coues's own book, *Citizen Bird* (1897), coauthored with Mabel Osgood Wright, were followed by other important commissions soon after his graduation in 1897. Among these were eighteen illustrations for *Song Birds and Water Fowl* by H. E. Parkhurst (1897), a color frontispiece for *On The Birds' Highway* by R. Heber Howe, Jr. (1899), and a series of illustrations to be used in the American Ornithologists' Union's publication, *The Auk*.

Fuertes' decision to enter a full-time career in bird painting without the security of an independent income was unprecedented in the United States. But, as almost everyone agreed, so was Louis Fuertes. In 1897, Elliott Coues wrote to Fuertes' mother:

> I have had the handling of a good many boys who wanted to do this or that in science. I have uniformly told them that the first thing was to secure a means of livelihood...and to come to me again, in the matter of ornithology, when they had become self-supporting in some practical trade, business or other occupation. With Louis it is different. If things turn out as I expect, the thousand dollars or so he will put in his pocket for this work *[Citizen Bird]* is very little in comparison with what he will be able to earn soon. He should be independent of the world from the start; if his work goes on as it should, he could command more than a fair price for the productions of his pencil and brush.

Fuertes attributed much of his early success to Coues. He had introduced Fuertes to many of the authors whose books he illustrated and was directly responsible for securing several of his most important commissions.

Fuertes acknowledged as his other great mentor Abbott Thayer (1849–1921), an American artist well known for his idealized paintings of women and chilren and for his original theories on the optical properties of color and light.

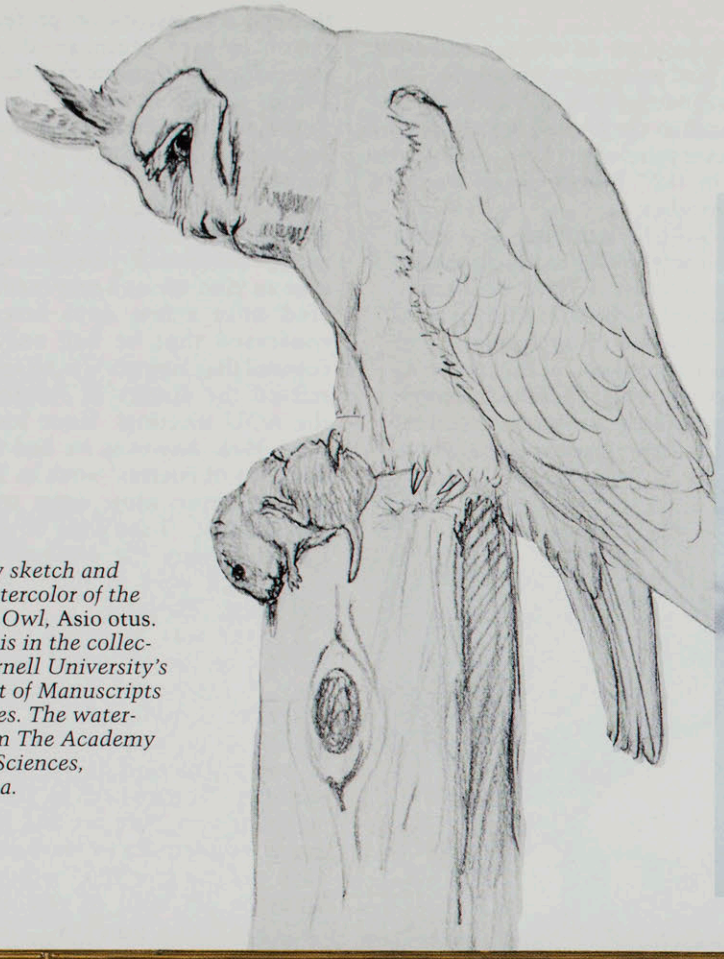
Fuertes first came to know Thayer through discussions on protective coloration in bird plumage at a national meeting of the American Ornithologists' Union (AOU) in 1896. Thayer was so impressed by Fuertes' ideas that he wrote suggesting that Fuertes visit him at his home in Scarborough, New York. "What you said at the AOU in Cambridge struck me instantly as looking like new truth," he wrote. "I hope you may consent to visit me as I proposed." In a hurried note a few days later, Thayer confessed that he had only just discovered that Fuertes was an artist (he had missed the display of Fuertes' work at the AOU meeting). Since his return to New York, however, he had seen reproductions of Fuertes' work in *The Osprey* and was even more eager to meet the young artist. "I can't say how peculiarly I should enjoy the company of a man doing such work as you....Yours is the real thing," he wrote.

Thayer was as eager to introduce Fuertes to the art world as Coues had been to expose the young artist to the scientific community, and he soon extended his invitation for a visit to an offer of free instruction during the following summer. "Somewhere in you there is a strain of very pure art and it would respond wonderfully to some pure training such as I can give you," wrote Thayer. "I want to get hold of you and swiftly develop your powers...Your talent makes me itch to train it, the more because it runs to my beloved birds."

Fuertes accepted the invitation, joining the Thayers in Dublin, New Hampshire, in the month following his graduation from Cornell. There he received the first professional art training of his career and began a long and fruitful relationship with Thayer and the other members of his family.

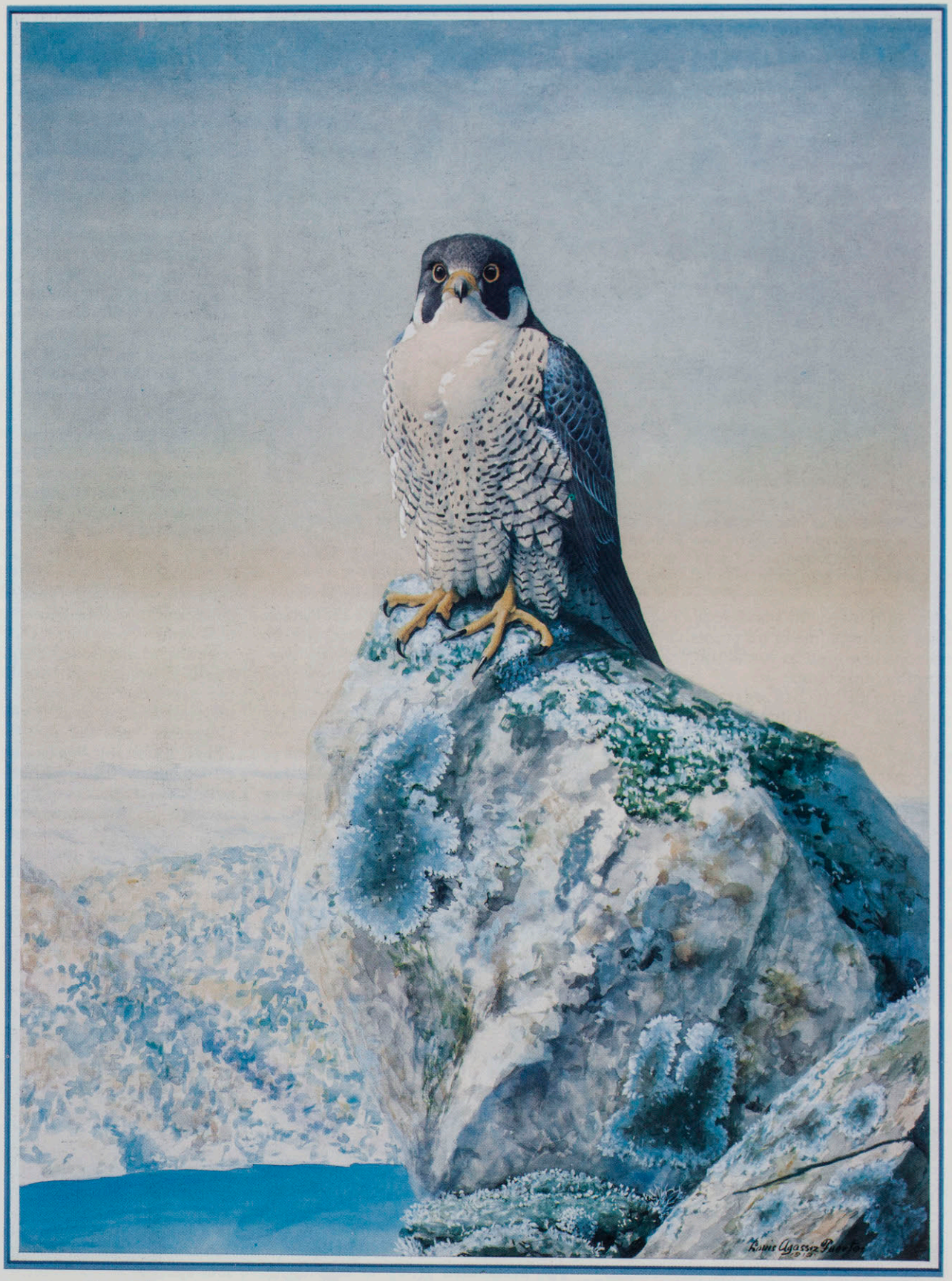
Elliott Coues and Abbott Thayer did much to promote Fuertes' career, but their differing expectations of his work and contradictory instruction for its execution caused Fuertes considerable difficulty. As a scientist, Coues called upon Fuertes for clear, accurate, identifiable depictions of birds well suited to publication in ornithological texts. "Keep your accessories down," he advised. "What we want is the *bird*, with least possible scenery, stage setting, framework or background of any description." Thayer, by contrast, believed context was everything. Not only is a bird's plumage genetically "matched" to its habitat, he argued, but it receives reflected light from its environment, further melding it into a natural background. To paint a bird accurately, he proposed, the artist should make it totally disappear into a natural habitat as it would in life. "The fact that a woodcock could sit on top of a church steeple [i.e. against a clear blue background] doesn't make it either art or science to

Lammergeier, Gypaetus barbatus. *Watercolor study. Courtesy of the Field Museum of Natural History.*

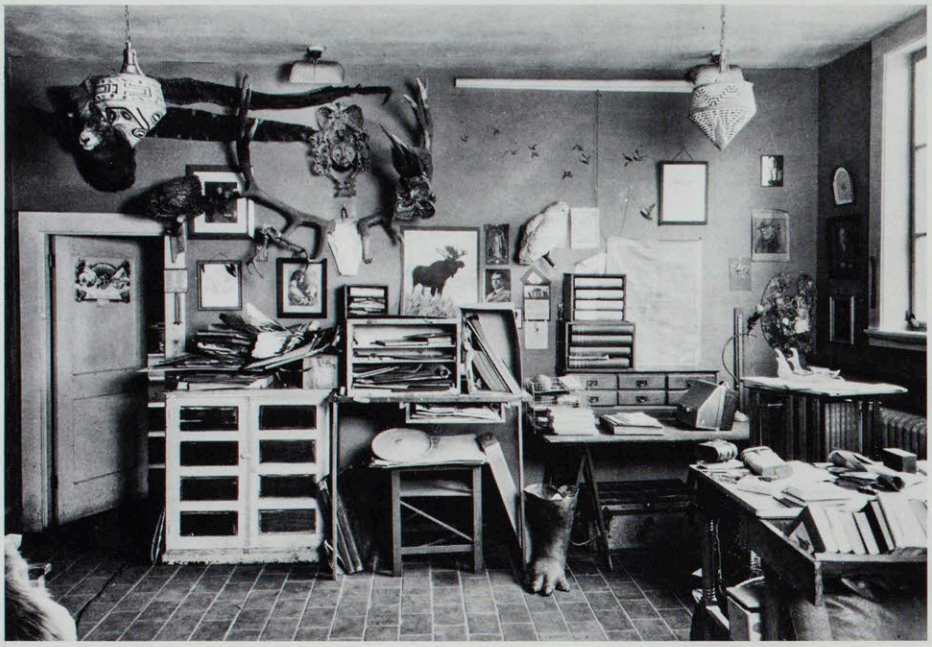


Preliminary sketch and finished watercolor of the Long-eared Owl, Asio otus. *The sketch is in the collections of Cornell University's Department of Manuscripts and Archives. The watercolor is from The Academy of Natural Sciences, Philadelphia.*

American Flamingo, Phoenicopterus ruber. *Following a trip to the Bahamas in 1920, Fuertes produced a number of large oil paintings of flamingos. Although he preferred to work in watercolors, this and the few other oil paintings he made reveal his versatility in working with different media. Courtesy of the American Museum of Natural History.*



Peregrine Falcon, Falco peregrinus. *Although Fuertes enjoyed painting birds of all kinds, he especially loved birds of prey. "I believe you know that the birds of prey are little less than a passion with me," he wrote to a colleague in 1915. It was a passion he reflected in his art. During the 1920s he painted a number of large owls and falcons, not as illustrations, but as gifts to friends or for sale through his dealer, the prestigious Kennedy Galleries in New York. Fuertes enjoyed the freedom of composing without the constraints of a publisher or the demands of a pressing client. In these paintings he often adopted an especially large format in order to show off the birds and to include background details not required in his illustration commissions. The Peregrine Falcon is an example of such work. Watercolor. Private Collection.*



A view of the Ithaca studio where, surrounded by Indian blankets, mounted birds, skins, cartoons, sketches, and anthropological artifacts from around the world, Louis Agassiz Fuertes painted more bird portraits than any artist had ever before attempted. "When I started," he once explained, "there wasn't any field [of professional bird painting], but one developed, and now there is considerably more of a one than one man can fill."

paint him there," he once chided Fuertes after viewing some of his student's illustrations in which he found too little environmental context.

Throughout his career, Fuertes struggled with this dilemma: whether to make his subjects clearly visible, and thereby please his clients, or intentionally obscure the birds he painted by applying Thayer's theories of camouflage and light, which he knew to be correct. The economic considerations of a wife and two children sometimes forced him to take on commissions that demanded the first approach; but more often he was able to effect an acceptable compromise in his work by incorporating enough habitat to demonstrate the theory of camouflage without totally obliterating the subject.

Whatever his compositional formula, Fuertes' successful depiction of the anatomy, plumage, posture, and suggested behavior of birds continues to set his work apart from the more prosaic depictions by less knowledgeable artists. "To one who knows birds," writes Roger Tory Peterson, "there is far more latent life in a Fuertes bird, composed and at rest, than there is in an Audubon bird wildly animated." Fuertes was able to capture the life of his subjects because he had spent so much time observing them in the wild. In this regard his knowledge and experience were unprecedented.

Fortunately for Fuertes, his conspicuous talent and genial personality resulted in a seemingly endless string of invitations to participate in scientific expeditions around the world. The first of these came in 1899 when Fuertes traveled to Alaska as part of a 126-person expedition privately sponsored by the New York financier Edward Henry Harriman. The expedition, deemed "remarkable for the number of noted men participating" and the "completeness of [its] equipment" by one West Coast newspaper, was by far the most luxurious of the many trips Fuertes would take during his career. Besides a crew of sixty-five officers and men and an additional force of eleven hunters, packers, and campers to assist the landing parties, the Harrimans took physicians, stenographers, a chaplain, a nurse, and four family servants. The scientific staff of thirty comprised many of the country's leading botanists, zoologists, geologists, and photographers, including the influential naturalist John Burroughs, the most popular natural history writer of his day; John Muir, America's leading conservationist; George Bird Grinnell, editor of *Forest and Stream* and one of the founders of the National Audubon Society; William H. Dall, the Alaskan explorer for whom the Dall sheep is named; Robert Ridgway, curator of birds in the National Museum and president of the AOU; Edward S. Curtis, the highly acclaimed Indian photographer; and a host of other important and influential figures.

The assembled group of dignitaries, which Fuertes described as "a big happy family," left Seattle on May 30, 1899, and cruised north and west, visiting Sitka, Glacier Bay, the Aleutian Islands, and Siberia. The primary geographic discoveries of the trip were a large, unknown fjord, subsequently named for Harriman, and its five live glaciers. Among the thousands of biological specimens collected on the expedition were more than 13 genera and 600 species new to science. These consisted primarily of plants, insects, and small mammals. Although all of the western birds were new to Fuertes, they had been previously recorded by other ornithologists and could not be counted among the expedition's discoveries.

Fuertes returned from the 4,327-mile journey with over a hundred bird skins, a portfolio full of pencil sketches and watercolors, and a host of new friends, many of whom he would keep for the rest of his life. The official report of the expedition, written by John Burroughs, contained sixteen of Fuertes' bird paintings.

Subsequent field trips took him to Texas (1901); the Bahamas (1902); Nevada, Colorado, New Mexico, and California (1903); Jamaica (1904); Saskatchewan and Alberta (1907); Florida (1908); Magdalen Islands in the Gulf of St. Lawrence (1909); Yucatan (1910); Colombia (1911 and 1913); the Bahamas (1920); Florida (1921); and Abyssinia (Ethiopia) (1926).

Fuertes relished these field experiences and the exotic places to which they took him. "You know that I was born with the itching foot," he once wrote Dr. Frank Chapman, an ornithologist from the American Museum of Natural History, in response to an invitation to visit Colombia, "and the sight of a map—or even a time-table—is enough to stir me all up inside." But while he loved the adventurous aspects of field research, he rejected "the gratuitous search for adventure" as "the bane of a working expedition." As his trip journals and copious letters from the field indicate, Fuertes had no need for such search; the nature, time, and location of the expeditions he joined guaranteed adventure. His many exhilarating, and at times harrowing, experiences in the field were anything but gratuitous. On one occasion he was held prisoner by a group of African tribesmen hoping for lucrative ransom in the form of whiskey and tobacco; on another, the artist narrowly escaped serious injury or death when he was bitten by a wounded mamba, one of the most poisonous snake species in the world. Such dangers were of little concern to Fuertes, however, and he seemed to thrive on the adversity he encountered in the field.

While the primary purpose of his museum-sponsored expeditions was to collect specimens and field notes to aid in the construction of dioramas or habitat groups for the museums that paid for the trips, Fuertes was generally given permission to retain his own notes and drawings and whatever specimens he himself collected. Like Wilson and Audubon before him, Fuertes recognized the essential role of collected skins and

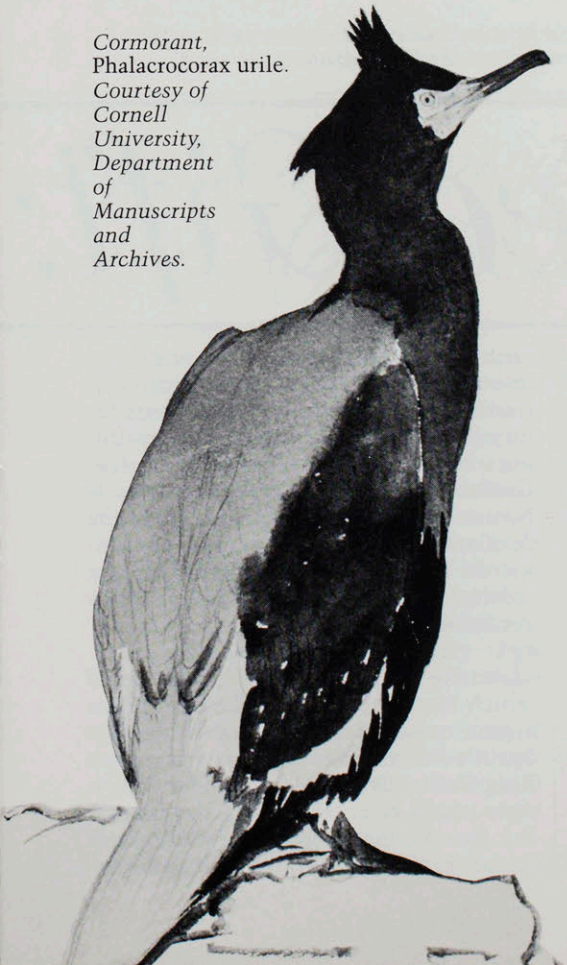
field sketches in ornithological portraiture. He understood better than anyone before him the transient nature of certain pigments that characterize living species. In an essay on the subject published in 1910, Fuertes wrote:

> Almost all water birds, the birds of prey, and many land birds have colors in life, and especially at the breeding season, which cannot in any known way be preserved. The bills of many ducks are varied and bright in color and often swollen or queer in form which shrink and dry dull colored in a specimen. The skin about the eyes and the eyes themselves of the hawks are often bright and unexpected colors. All such characteristics must be painted carefully from either living or freshly shot birds....

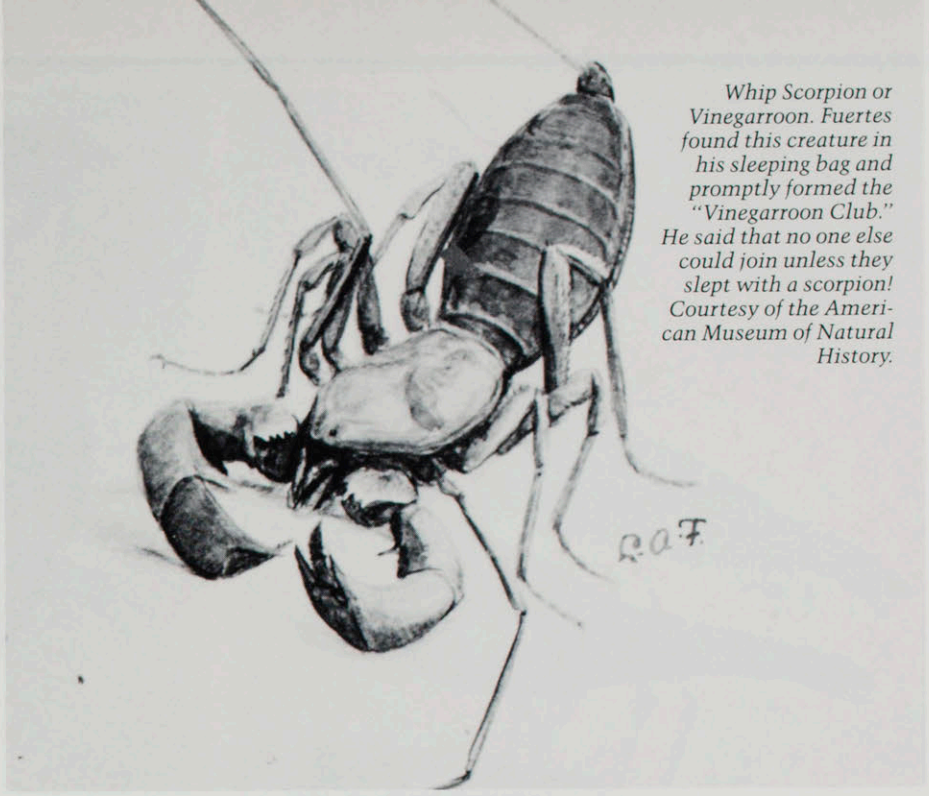
Fuertes considered his field notes and paintings "the most important and valuable part" of his equipment, and he maintained them, along with his own collection of study skins, as a permanent reference library for his finished paintings.

The intensity with which Fuertes worked—and the resulting success of his paintings—is suggested by this account of his behavior by his friend and frequent traveling companion, Frank Chapman:

> Fuertes in possession of a freshly captured specimen of some bird which was before unknown to him is, for the time, wholly beyond the reach of all sensations other than those occasioned by the specimen before him. His concentration annihilates his surrounding. Color, pattern, form, contour, minute details of structure, all are absorbed and assimilated so completely that they become part of himself, and they can be reproduced at any future time with amazing accuracy. Less consciously, but not less thoroughly and effectively, does he store impressions of the bird's appearance in life, its pose, mannerisms, characteristic gestures of wings, tail or crest, its facial expression—all are recorded with surprising fidelity.



Cormorant, Phalacrocorax urile. *Courtesy of Cornell University, Department of Manuscripts and Archives.*



Whip Scorpion or Vinegarroon. Fuertes found this creature in his sleeping bag and promptly formed the "Vinegarroon Club." He said that no one else could join unless they slept with a scorpion! Courtesy of the American Museum of Natural History.

In all, during the thirty years of his professional career, Fuertes prepared illustrations for more than thirty-five books and approximately fifty educational leaflets, handbooks, and bulletins. He was a tireless worker and contributed regularly to more than a dozen popular and scholarly journals.

Fuertes occasionally accepted advertising projects, too. The most successful, and perhaps the best known, was for the Church and Dwight Company, distributors of Arm and Hammer Baking Soda. In the 1920s, for his friend and fellow conservationist Charles T. Church, Fuertes painted 120 bird portraits. The plan was to include a reproduction in each package of baking soda. There were four series of thirty studies each: song birds (two different sets), game birds, and birds of prey (the last not published until 1976). These small reproductions were collected as avidly as baseball cards—especially by children—and did much to increase public knowledge of ornithology.

Despite the unparalleled success of his scientific illustrations, in the mid-1920s Fuertes began to experiment with more inventive compositions. He indicated to his friends and family that when his current commissions were completed he intended to devote more time to painting for its own sake.

Unfortunately he was never to have the opportunity. Following his participation in the seven-month expedition in Abyssinia, during which he created "the best lot of field studies I ever did on one trip," Fuertes was killed in an automobile accident at a grade crossing near Unadilla, New York. He and his wife were returning from a visit with the Frank Chapmans, to whom Fuertes had been showing his Abyssinian paintings. His wife was slightly injured in the accident. The paintings, miraculously, were thrown clear of the wreck.

During a memorial service for Fuertes a few months later, Frank Chapman stated:

> If the birds of the world had met to select a human being who could best express to mankind the beauty and charm of their forms, their songs, their rhythmic flight, their manners for the heart's delight, they would unquestionably have chosen Louis Fuertes.

Fuertes himself could not have asked for a finer tribute.

Robert McCracken Peck, a Fellow of The Academy of Natural Sciences of Philadelphia, is author of A Celebration of Birds: The Life and Art of Louis Agassiz Fuertes *(New York: Walker & Co., 1982) and curator of the national traveling exhibition that bears the same title. His articles have appeared in* American Art Review, Arts Magazine, Audubon, National Wildlife, *and other publications.*

American Kestrel. Inscribed Falco sparverius, *male. Courtesy of the Hunt Institute.*

Aplomado Falcon. Inscribed Falco femoralis. *Courtesy of the Hunt Institute.*

Two illustrations of the Black-necked Stilt, Himantopus mexicanus, *both inscribed* Charadrius himantopus. *The one on the left is in the collections of the Hunt Institute; the illustration on the right is from the Museo Nacional de Ciencias Naturales, Madrid.*

The Unopened Gift:

Spain's Contributions to Science during the Age of Enlightenment

by IRIS H. W. ENGSTRAND

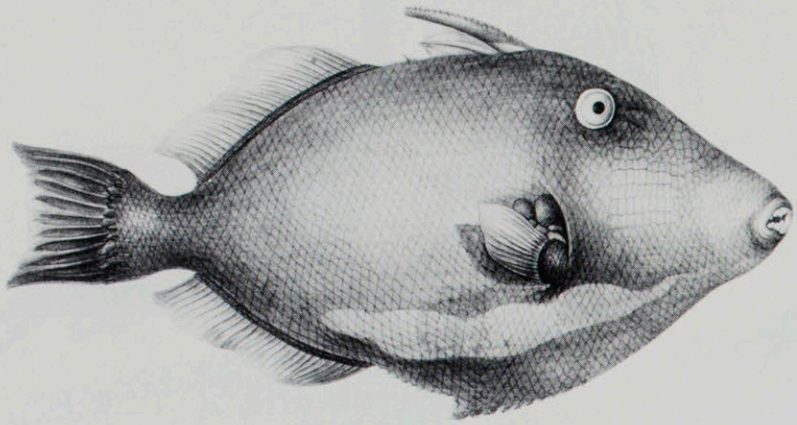
Spain, in the final decades of the eighteenth century, reached a zenith in scientific exploration. Her naturalists surveyed, identified, and cataloged, according to the Linnaean system, literally thousands of new species throughout the Old and New Worlds. As the work of her skillful investigators and talented artists approached the threshold of international recognition, disaster struck. Precisely when the fruits of many years' painstaking labor were about to be realized, a series of court intrigues and the French invasion of 1808 left Spanish scientists in chaotic circumstances. The documents and illustrations that chronicled Spain's remarkable effort in the great era of Enlightenment remained unedited and unpublished. As a result, winners in the the competition for discovering and naming new species were from other nations. In fact, it is only now, nearly two hundred years later, that Spain's accomplishments can be placed in proper perspective.

Although several books and articles have recently brought the work of Spain's Royal Scientific Expedition to a variety of readers, the most spectacular publicity has come from two thousand watercolor paintings of fauna and flora that have lain virtually untouched since 1820 when their owner, Mexican botanist José Mariano Moziño, died in Barcelona. Acquired by the Hunt Institute for Botanical Documentation at Carnegie-Mellon University in 1981, these exquisite illustrations are just beginning to be examined and evaluated for their significance to the scientific community. They complement 84 similar paintings housed in the Royal Botanical Garden of Madrid, 33 in the Museum of Natural Science (Madrid), and 305 in the de Candolle collection at the Conservatoire Botanique in Geneva. They give colorful recognition to an effort that may yet achieve its original goal.

The Royal Scientific Expedition, of which Moziño (also spelled Mociño) was a part, resulted from the patronage of Spain's enlightened Bourbon monarch King Carlos III (1759–1788). The Crown encouraged scientific study throughout the Iberian Peninsula and promoted a number of exploring expeditions designed to survey and examine the natural resources of Spain's overseas empire. These efforts provided a vast laboratory for scientists trained at the newly established Museum of Natural Science and Royal Botanical Garden of Madrid. Spurred on by the work of European colleagues and excited by the amount of new information resulting from the expeditions of Captain James Cook, Louis Antoine de Bougainville, and others, Spaniards were eager to apply their knowledge to the unexplored territories of North and South America.

During the 1780s several expeditions were sent to Spain's New World territories. Botanists Hipólito Ruiz and José Pavón traveled to Peru and Chile while José Celestino Mutis collected and classified the flora of present-day Colombia and Ecuador. At the end of the decade, the Around-the-World Expedition of Alejandro Malaspina (1789–1794) continued the Spanish endeavor in the Americas and extended it to the Philippine Islands, Australia, and other Pacific areas. Carlos III unfortunately died in 1788, and continued support was not forthcoming. Only Ruiz and Pavón succeeded in having a portion of their flora published within a reasonable time (three volumes between 1798 and 1802 with the remaining volumes achieving publication in the late 1950s). Malaspina and his scientists, who first broke into print in 1885, were the subject of an exhibition at the Natural History Museum of Los Angeles County in 1977 and featured in the Spring 1977 issue of TERRA.

Unlike the strictly exploring expeditions, the Royal Scientific Expedition, or Royal Botanical Expedition as it is sometimes called, was to establish a permanent Botanical Garden and Institute of Botany in Mexico City. Directed by Martín de Sessé, a physician from the Spanish province of Aragon, it was sponsored by Carlos III and supported by Casimiro Gómez Ortega, head of the Royal Botanical Garden of Madrid. Because medicinal plants were a major botanical objective, Gómez Ortega recommended the appointment of Juan del Castillo, Vicente de Cervantes, and Jayme Senseve, all pharmacists, for work in botany and naturalist José Longinos Martínez, a surgeon and taxidermist, to study fauna rather than flora. They would be joined by two artists from either Spain or Mexico and several servants.



Queen trigger fish.
Inscribed Balistes vetula.
Courtesy of the Hunt Institute.

Members of the expedition were to collect salaries from the royal treasury for a period of six years, during which time they were to "examine, draw, and describe methodically" all natural products of New Spain. This region, with its capital in Mexico City, extended from Central America to Alaska, including the southwestern United States and portions of the Caribbean. They were also to complete the unfinished work left by Francisco Hernández, a sixteenth century Spanish scientist who directed an expedition to New Spain under orders of Philip II. Hernández had prepared sixteen volumes for publication, but these were left unprinted in the archives of El Escorial near Madrid. A fire destroyed ten volumes in 1671 and the remaining six were in the process of being edited for publication by Gómez Ortega.

In his search for illustrators, Sessé interviewed Jerónimo Antonio Gil, director of the Royal Art Academy of San Carlos in Mexico. Gil suggested two excellent students—Atanasio Echeverría and Vicente de la Cerda. Impressed with their work, Sessé hired them to work at the garden as well as in the field. Both artists were extremely capable, although Sessé felt the eighteen-year-old Echeverría greatly surpassed Cerda in ability. The artists, who were not only talented but agreeable and easygoing, were assisted from time to time by others from the academy. With the addition of the paintings at the Hunt Institute, the illustrations known today number approximately 2,400, with the majority in full watercolor. All are done precisely, often through hand lenses, to show details not visible to the naked eye. Some are painted only in part, showing a representative flower, a series of leaves, and a portion of the stem. Perhaps they were to be filled in at a later time. Only one is signed by Echeverría, none shows the signature of Cerda, and two bear the name of Pedro Oliver, an assistant.

The work of the expedition went smoothly for everyone except the naturalist Longinos. He was unhappy because Sessé insisted that all should travel together searching for plants. Longinos wanted to locate and describe fauna and finally received permission to take Echeverría to areas likely to yield better results. They probably worked together in the ports of Acapulco and San Blas. For this reason the paintings of birds, fish, reptiles, quadrupeds, and butterflies should be those of Echeverría. Longinos eventually traveled alone to the Californias, making an extensive overland journey from Cabo San Lucas to Monterey in 1791 and 1792. No specific drawings from that particular trip have yet been identified. While still in Mexico, Longinos sent several shipments of stuffed birds to Queen María Luisa of Parma, wife of Spain's King Carlos IV, son and successor of Carlos III in 1788. Sessé disagreed with many classifications made by Longinos and wrote in his own. Often neither was correct since, like many eighteenth century scientists, they were classifying species in terms of Old World designations.

While some members of the expedition were gathering specimens, Cervantes conducted courses in botany. The institute adjoined the viceroy's palace on the Zócalo, Mexico City's central plaza. The class of 1789 was signalized by the attendance of José Mariano Moziño, a native of Temascaltepec, Mexico, who had been a professor of theology and a graduate of medical school. At the graduation exercises, Moziño defended the Linnaean system of nomenclature and received honor as the year's outstanding student. Because of his desire to pursue further botanical studies, Sessé created a temporary position for him in the expedition. The Viceroy of New Spain approved the action, but it was later disallowed by King Carlos IV. Moziño nevertheless participated in the third botanical excursion, which covered the territory northwest of Mexico City through Querétaro, Guanajuato, Pátzcuaro, Uruapan, Apatzingan, and Guadalajara.

Because Moziño lacked official status with the royal scientific expedition, the viceroy appointed him to accompany Juan Francisco de la Bodega y Quadra on a voyage to the Pacific Northwest. They met with British Captain George Vancouver at Nootka Sound in late spring, 1792. While the leaders discussed conflicting claims of Spain and England in the northern region, Moziño carefully studied the area's natural resources. He was joined by Echeverría who painted fauna and flora and also sketched scenes of Indians and their activities. Copies of these drawings in black and white are preserved in the Ministry of Foreign Relations in Madrid, and some have been acquired by the Canadian government. Several illustrations in the Hunt Institute are the original watercolor paintings of plants and fish from the Vancouver Island area.

Moziño, during his six months stay at Nootka Sound, learned the language of the native Indians and made a thorough investigation of Spain's most northerly outpost. Extending his study considerably beyond a mere botanical survey, he compiled *Noticias de Nutka*, a geographical description of the area with an account of the customs, government, rites, chronology, music, poetry, and economic activities of the Indians. Moziño also included a history of European voyages to Nootka (including the one by Captain James Cook in 1778), added a dictionary of the native language, and classified more than two hundred species of plants and animals. Echeverría, along with his artistic duties, helped gather many of these species. Spain, in the face of British pressure, withdrew from Nootka in 1795.

The Bodega expedition returned to

New World leaf-nosed bat, drawn by Echeverria, Royal Scientific Expedition. Inscribed Vespertilio spectrum. *Courtesy of the Museo Nacional de Ciencias Naturales, Madrid.*

Mexico in September 1792, stopping for a time in California. Rogers McVaugh, whose *Botanical Results of the Sessé & Mociño Expedition (1787–1803)* was published by the University of Michigan Herbarium in 1977, has concluded from the available drawings in the de Candolle collection in Geneva and his investigations in Madrid that certain plants studied were native to central or southern California. Although specific documentation is lacking, it is believed that Moziño spent about three months in Monterey and other areas of California (a study of the newly found drawings may assist in more precise determination). Moziño returned to San Blas, Mexico, in February 1793 and, after ten weeks travel, rejoined Sessé's group.

While Moziño was pursuing his northern excursions, Sessé, with Castillo and Cerda, set out on a series of field explorations throughout the present state of Mexico. They were in Temascaltepec in August 1792 and described species from the Valley and Volcano of Toluca; in September they were in Ixmiquilpan. They visited Jalapa in November and Puebla in December. Sessé was back in the capital early in 1793 and spent some time with Cervantes at the botanical garden before setting out again. Moziño was officially brought into the expedition following the unexpected death of Juan del Castillo in July. They all suffered from illness during the summer of 1793 but continued on. Sessé set up headquarters in Cordoba with Cerda, and Moziño left with Echeverría in September to investigate the erupting Volcano of San Andrés de Tuxtla south of Veracruz.

Julian Villar Pardo, an artist who had been with the Malaspina expedition in Mexico, joined Moziño on his trek to the volcano with the hope of becoming a permanent illustrator. His position seems to have been that of a volunteer, especially since he offered to work without a salary. Whatever his status, Villar accompanied Moziño and Cerda to Guatemala and Nicaragua since Echeverría left with Sessé and Senseve for the West Indies in May 1795.

Longinos, having returned from his separate travels to the Californias, was to accompany Moziño, Cerda, and Villar to Guatemala. Because of personality conflicts and his continuing desire to search out the local fauna, Longinos preferred to take a different route. He passed through the Tehuantepec area and reached Guatemala in early summer of 1796. He decided to remain in Guatemala City and apparently became a resident naturalist of some repute. He gave lessons in botany and established a small museum of natural history. Moziño, Cerda, and Villar did some extensive collecting in Guatemala, visited Longinos, and then continued on to El Salvador and Nicaragua. They remained there for nearly two years, returning to Mexico early in 1799 with an extensive manuscript entitled Flora of Guatemala. Longinos died on an excursion to Campeche, Mexico, in 1802.

Sessé and Echeverría pursued their botanical activities near Havana in the fall and winter of 1795. Sessé added nearly one hundred citations of Cuban species to his manuscript Flora Mexicana. They sailed for Puerto Rico and covered most of the island in 1796 and 1797. The variety of locations gave them approximately 180 new plants. When Sessé returned to Mexico, Echeverría stayed in Cuba to join Spanish botanist Baltasar Boldó, then attached to a military reconnaissance under the Conde de Mopox y Jaruco. The artist remained on the island for several years completing a series of maps and drawings of ports and military installations.

Despite some royal protests, Sessé's expedition received a two-year extension of its original six-year contract. All participants were supposed to return to Spain in 1796, but Sessé chose not to abandon his many projects. By extending his survey to the West Indies and Central America, he postponed the inevitable for two more years but continued to receive orders for the expedition's immediate return. Vicente Cervantes elected to remain in Mexico as head of the Botanical Garden and Cerda decided to stay with him. Sessé was disappointed in the art-

Iguana. Courtesy of the Hunt Institute.

Grasshopper. Courtesy of the Hunt Institute.

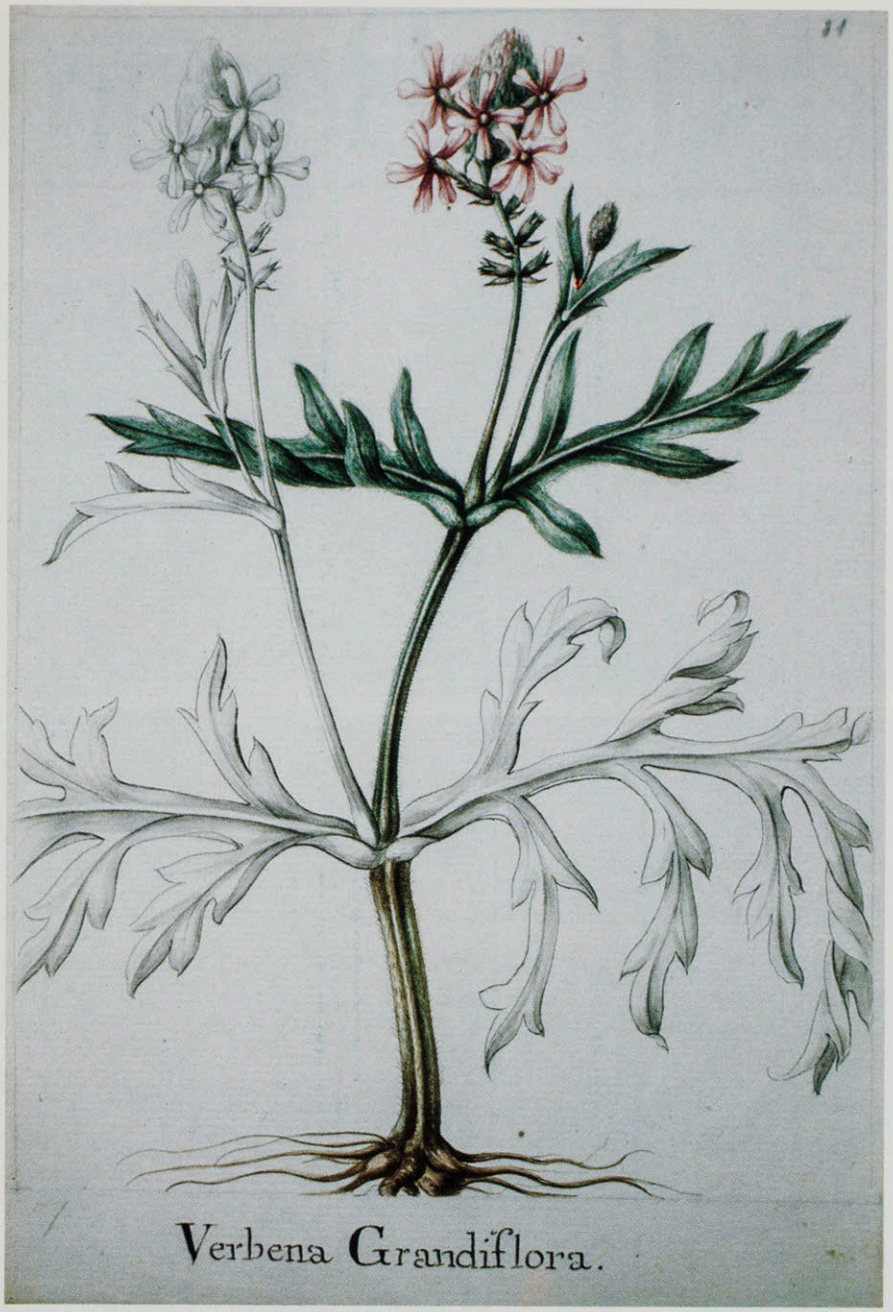
New World Mouse, juvenile. Inscribed Mus brevipes. *Courtesy of the Hunt Institute.*

ist's decision since he knew Echeverría would be in Cuba. Nevertheless, the group that finally departed in 1803 for Madrid consisted of Sessé and his family, Moziño (without his wife from whom he had been long separated), and Senseve.

Upon their return, Carlos IV showed little effective interest in projects of natural history and offered them no means for publication of their reports. Their manuscripts, drawings, and herbaria were at first given by the government to Ruiz and Pavón, authors of *Flora peruviana et chilensis*, for examination. Sessé objected strongly and regained possession of his materials. As they began editing the work, Senseve died of a sudden illness in 1804. This left Sessé and Moziño with a considerable chore. Although Echeverría returned from Cuba, he devoted little time to the Mexican project even though he stayed in Madrid until 1808.

While Moziño lived in Madrid he became associated with the Royal Academy of Medicine and served as president for four terms between 1805 and 1812. Sessé died in 1808, and his wife and children returned to Mexico. Moziño, who had been living in Sessé's house, moved into quarters at the Academy of Medicine and tried to keep the collection protected and together. The political turmoil resulting from the abdication of Carlos IV in favor of his son in 1808 actually brought relief to Moziño. When Napoleon's forces triumphed in Madrid, allowing Joseph Bonaparte to occupy the throne, the new monarch appointed Moziño director of the Royal Museum of Natural History. Moziño remained at this post after the French withdrew from Madrid in 1812, believing himself to be in no danger. The returning Spanish patriots, however, did not favor his having worked for the invaders. He was deemed a traitor and, along with other scientists and distinguished persons, placed in chains and led away to be imprisoned.

Some distance to the north, a French general set the unfortunate group free, and Moziño returned to Madrid to gather together what he could. He placed the



Verbena. Inscribed Verbena grandiflora.
Courtesy of Real Jardin Botanico, Madrid

most valuable objects of the museum, his manuscripts and drawings, in an old hand cart that he walked beside during the day and slept in at night. Near the border a French officer seized the cart, and Moziño was able to save only his papers, with which he fled from Spain and took refuge in Montpellier. Here he met Swiss botanist Augustin Pyramus de Candolle, who became fascinated by Moziño's paintings. De Candolle believed Moziño's identifications to be of minimal value and preferred to work from the precise illustrations in classifying the new species. In 1816 he asked Moziño to accompany him to Geneva, but instead Moziño declined and offered the materials to his Swiss colleague.

During the year that followed, Moziño secured permission to return to Spain. A cordial invitation to Madrid by the Spanish minister of Marine prompted him to ask for the return of his paintings, with the exception of 305 duplicate originals. De Candolle, not wanting to lose them completely, had a number of artists and amateurs of Geneva, mostly women, trace as many as possible. In fewer than eight days, 860 sketches were copied entirely and 119 preserved as rough drafts. The original illustrations were then turned over to Moziño, who proceeded to Madrid by way of Barcelona.

Moziño never reached his destination. He apparently remained for some time in Barcelona to organize his collection. He died there in 1820 and was buried in the parish church cemetery of St. James. The two thousand drawings, as well as some personal effects, remained in the possession of Dr. Rafael Esteva. According to correspondence of 1862 in the Museum of Natural Science in Madrid, the herbaria and manuscripts of Flora Mexicana reached the Botanical Garden in 1820 but without the illustrations. The director of the museum requested their return in a series of letters continuing until 1869. Officials in Madrid insisted that the Moziño materials belonged to the Spanish government. Sometime during the 1880s the collection passed into the hands of the Torner family of Barcelona. Srs. Jaime and Luis Torner Pannochia inherited it from their father, who in turn had received it from his brother. They elected to place the perfectly preserved watercolors with the Hunt Institute.

The finished illustrations were intended to be used as the basis for engravings in a great book on the flora and fauna of New Spain. Instead, *Plantae Novae Hispaniae* (1887–1891) and *Flora Mexicana* (1891–1897), two botanical volumes based upon the manuscripts alone were published some one hundred years later in Mexico, and these did not represent fairly the work of the expedition. Both volumes, especially without the plates, were obsolete at the time of publication. They demonstrated, nevertheless, that Sessé and Moziño were competent botanists. The herbarium of the Royal Scientific Expedition is presently in the Instituto Botánico A. J. Cavanilles (Royal Botanical Garden) in Madrid. It shows that Moziño was working on some final organization of specimens making up a flora of New Spain. Despite the groups' lack of appropriate recognition, Moziño's association with de Candolle did bring Spain credit. The illustrations in Geneva formed the basis for 17 new genera and 271 new species, which the Swiss botanist included in his *Systema* and *Prodomus* published during the 1830s. Today they give testimony to the dedication of the scientists and artists who had such high hopes for them.

Dr. Engstrand is the author of Spanish Scientists in the New World: The Eighteenth Century Expeditions *(University of Washington Press, 1981) and translator and editor of* José Mariano Moziño's Noticias de Nutka: An Account of Nootka Sound in 1792 *(University of Washington Press, 1970). Both of these works give additional details about Spain's role in scientific investigation. Dr. Engstrand is presently professor and chair of history at the University of San Diego.*

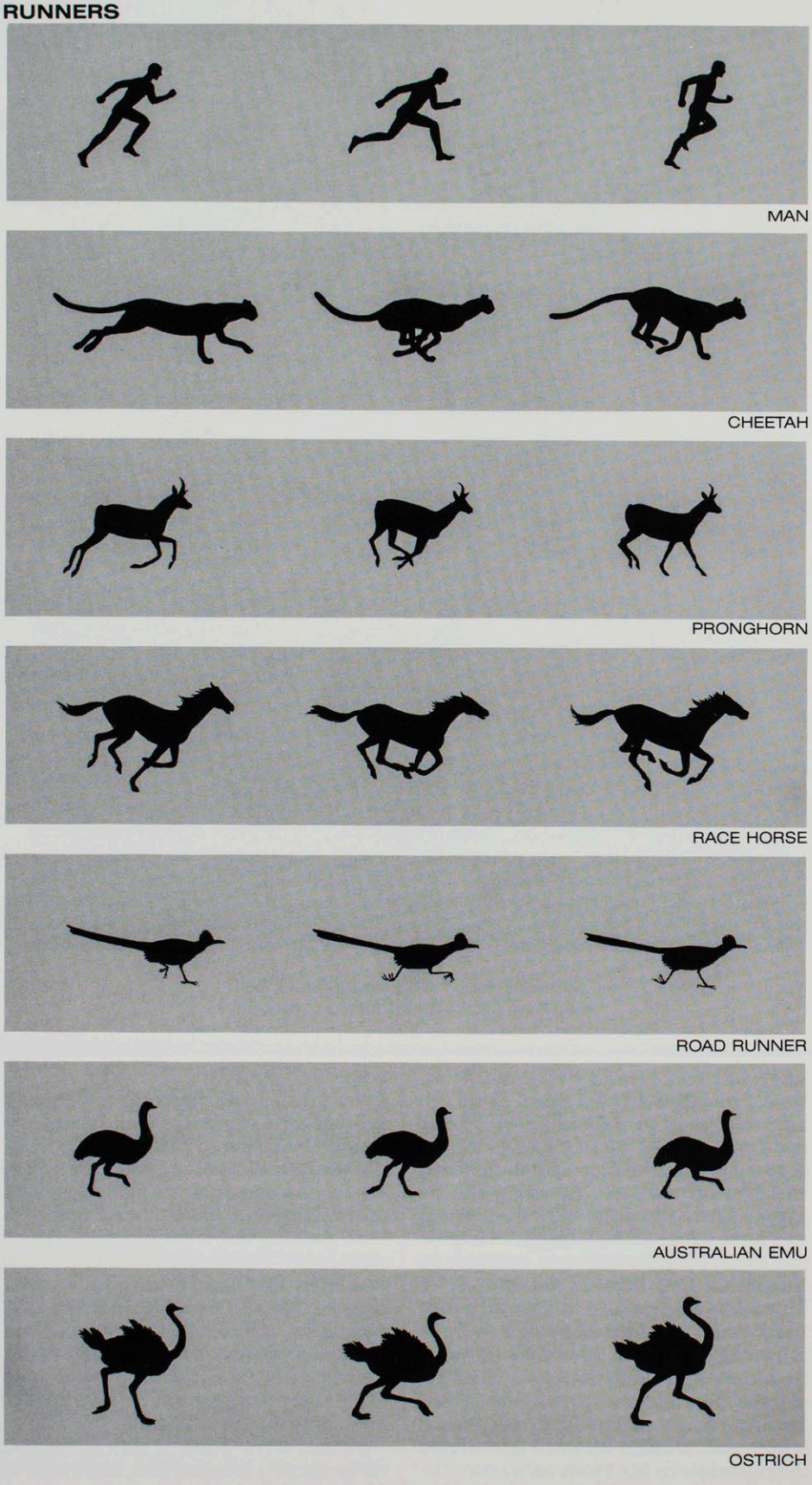
Research for this article was funded in part by the American Philosophical Society.

Who holds the Record?

Since near the turn of the century, athletes have been striving for excellence in the modern Olympic Games. Men and women continue to shatter records as they compete to win as well as for the sheer joy of sport. But the skills that we now use for recreation—racing along the surface of the ground, bounding over it, or swimming through the water—are basic to the survival of many animals whose abilities have been shaped over aeons of time through the need to escape from enemies and capture prey. How does mankind match up against his fellow species?

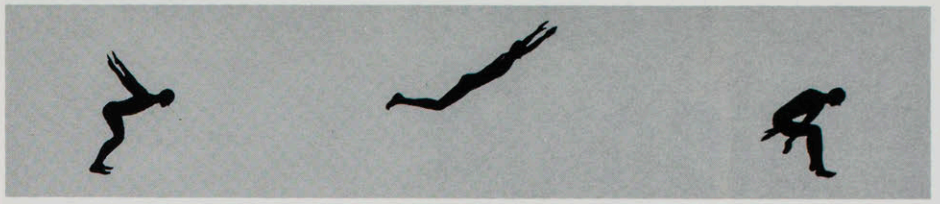
The Olympic record for sprinting was set by Jim Hines in 1968 when he covered 100 meters in 9.9 seconds, which converts to approximately 36.4 kilometers per hour or 22.6 miles per hour. Compare this human burst of speed with that of the cheetah, *Acinonyx jubatus*, of South west Asia and East Africa; with clocked records of 69.8 km per hr (43.4 mph) and claims for its speed as high as 135 km per hr (83.9 mph), the Cheetah is considered to be the fastest-moving terrestrial animal.

The North American record for speed on land is held by the Pronghorn of the western plains, *Antilocapra americana*, which has been timed at 90.2 km per hr (61 mph). The fastest-known race horse travels almost two times faster than an Olympic champion at 69.6 km per hr (43.3 mph). Even some kinds of birds can run with surprising speed. Although an Olympic runner could beat our Roadrunner, *Geococcyx californianus*, which covers the ground at 32 km per hr (19.9 mph), other birds are far out in front. The Australian Emu, *Dromaeus novaehollandiae*, is reported to run at 50 km per hr (31.1 mph) as does a month-old Ostrich chick, *Struthio camelus*, while an adult Ostrich has been clocked at 70 km per hr (43.5 mph).

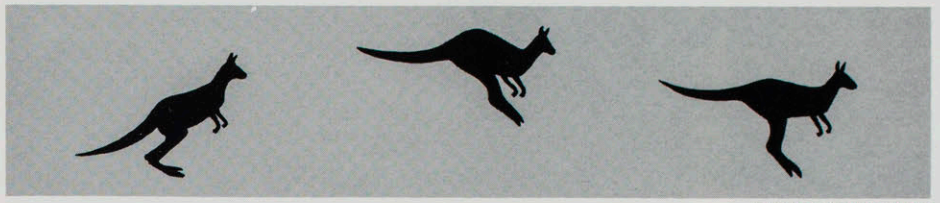


Illustrations by Mary Butler

HIGH JUMPERS



MAN

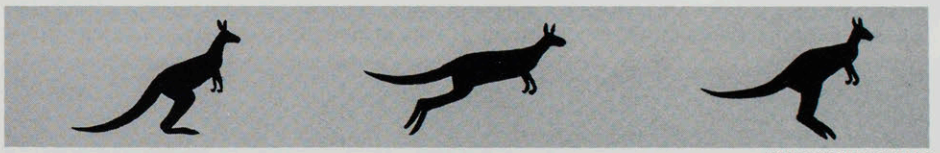


GRAY KANGAROO

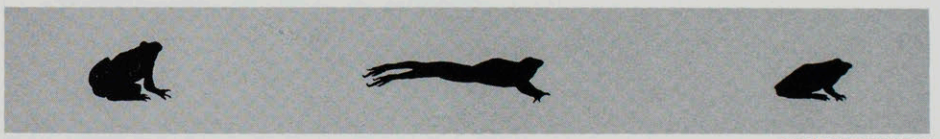
COMMON FLEA

BROAD JUMPERS

MAN



RED KANGAROO



CRICKET FROG

COMMON FLEA

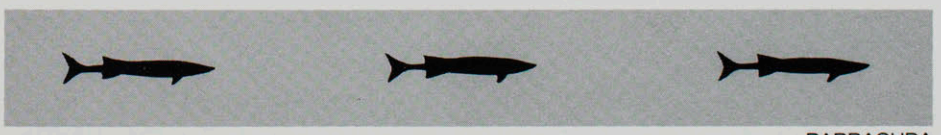
Let's go up in the air. The Olympic record for the long jump, set by Bob Beamon in 1968, is 8.9 meters (29 feet 2½ inches), and the record high jump, made by Gerd Wessig in 1980, is 2.4 meters (7 feet 8¾ inches). If we assume the average Olympic athlete stands at 1.9 meters (5 feet 11 inches), then the record long jumper travels through the air a distance about 4.9 times his own height, and the high jumper goes up about 1.3 times his height. The kangaroo is a well-known jumper, and there is a record of the Red Kangaroo of Australia, *Macropus rufus*, bounding 12.8 meters (42 feet) across the ground and of an Eastern Gray Kangaroo, *Macropus giganteus*, jumping 3.2 meters (10 feet 6 inches) up in the air. These kangaroos are about 2.3 meters (7 feet 6 inches) tall; hence, their record long jump is about 5.6 times body height and the high jump about 1.4 times body height. Olympic jumpers and kangaroos are not far different in their performance.

Other champion animal jumpers are found among the frogs, with the cricket frog, *Acris gryllus*, recorded as jumping an average of 31.1 times its body length (excluding the length of its legs) and making a championship jump 61.7 times its body length. A record-breaking leap of 5.35 meters (17 feet 6¾ inches) was made by an unidentified and unmeasured frog in 1975 at the Calaveras County Jumping Frog Contest.

Surely the most astonishing jumping record of all is held by the common flea, *Pulex irritans*, which is recorded as long jumping .33 meters (13 inches), more than 100 times its body length, and as high jumping about the same distance. If an Olympic athlete could jump the same distance relative to body length that fleas do, his leap would measure 180 meters (591 feet).

SWIMMERS

MAN



BARRACUDA

BULL SHARK

Swimming provides still another comparison. The Olympic record of 100 meters in 49.99 seconds set by Jim Montgomery in 1976 equals about 8.3 km per hour (5.1 mph). This figure converts to approximately 1.3 body lengths per second. Contrast human swimming speed against that of the great barracuda, which has been clocked at 44.3 km per hr (27.5 mph) or about 9.5 body lengths per second. Several species of tunas and marlins may swim even faster. The bull shark, *Carcharhinus leucas*, swimming at 18 km per hour (11.2 mph) or about 3.6 body lengths per second, is slower than the barracuda but still faster than a champion human swimmer.

DANIEL M. COHEN
Chief of Life Sciences

THE NATURAL HISTORY OF THE Madapple

by WILLIAM A. EMBODEN

I rather wish English men to content themselves with the meat and sauces of our owne country, than with fruit and sauce eaten with such perill; for doubtlesse these Apples have a mischievous qualitie, the use whereof is utterly to be forsaken.

John Gerard, The Herball or generall historie of plants, *London, 1597*

My first encounter with the madapple is forgotten, but madapple pasta in Venice will be remembered forever. It was the summer of 1980, and I was in a Venetian *legatoria,* an elegant stationery, near the church of San Moise. Within the confines of a few square feet there were hundreds of hand-printed Venetian papers and cards dazzling to the eye and dear to the purse. Having exhausted my senses in the glory of colorful blocked folio sheets, I asked the proprietess, Signora Scopini, if she could recommend a novel *trattoria* where I might find something unusual for lunch. "It's too hot to eat meat," she said, with absolute authority. "And if I tell you what you should eat you won't remember it... anyway, it is not on the menu." All of this was stated imperiously, as is her wont,

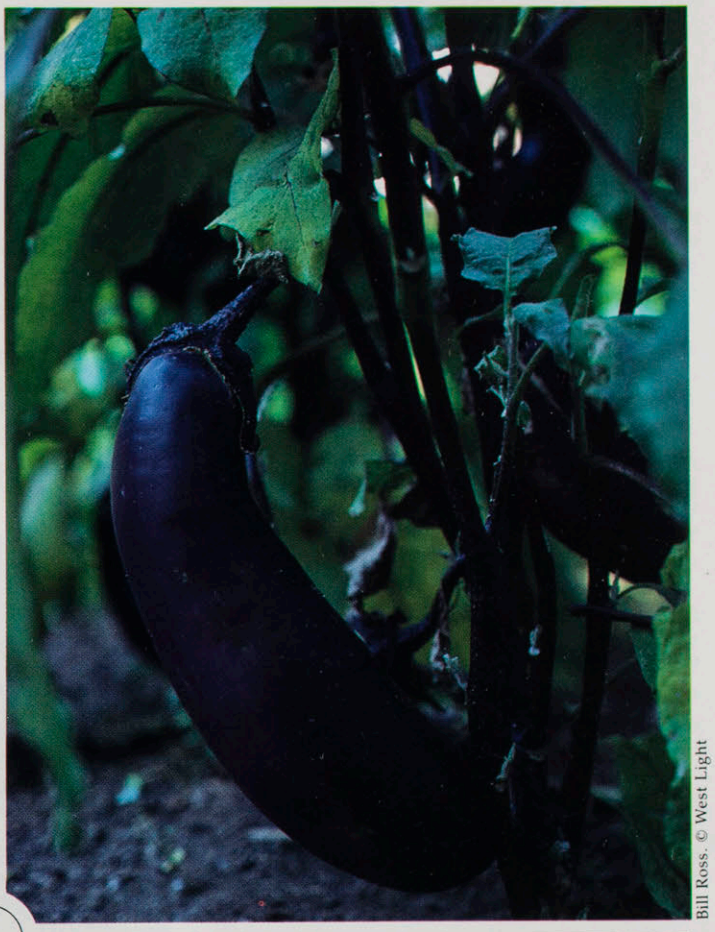
William A. Emboden

Detail of eggplant from a screen executed by the Japanese artist Hochu Nakamura (ca. 1800). Courtesy of Metropolitan Museum of Art.

A produce stand with eggplants.

Ronny Jaques. © Photo Researchers, Inc.

Japanese eggplant.



Bill Ross. © West Light

William A. Emboden

A flower of the madapple (Solanum melongena).

William A. Emboden

The rare white eggplant. Gerard stated that it has "the bigness of a Swanne's egge."

Woodcut of "Solanum insanum." From Planterum seu Stirpium Icones *(Pictures of Plants from Life) by Lobelius (Antwerp, 1581).*

but at the same time she was writing a note. She wrote on stationery with the imprint of Legatoria Piazzei and addressed the message to the chef of Trattori Ignazio, which is near the church of San Ignazio.

Everyone in Venice knows Signora Scopini. She is one of those few individuals to whom one may address a letter by merely using her name and the words *Venice, Italy.* She does not give misinformation except deliberately, and she rarely gives directions to a place where she herself might be found. In her many transformations, Signora Scopini brings to mind Alice in Wonderland.

The note that the Signora handed to me was brief: "Pasta ascuitta trappenese a piacere Signora Scopini." I accepted it gratefully, thinking that anything that would please Signora Scopini would most certainly please me. After all, it was she who introduced me to the drink known simply as "Bellini" (Venetian champagne that has been blended with a peach takes on the colors of this great painter—a Bellini is best consumed at the end of a day when the sky over the lagoon most closely approximates those same hues).

I made my way through the labyrinth of streets, piazzas, and piazettas that lead to the vine-covered *trattoria.* I was seated in the patio, and a waiter came to present me with a menu. Instead, I gave him the small folded note. He read this with astonishment and promptly darted off to the kitchen. There was a commotion, and then the chef, Signora Nina—a woman of around 60 years known for her keen eyes and marvelous smile, appeared. Signora Nina came to my table and stared at me with her hands placed firmly on her hips. She read the note and then disappeared into the kitchen without a word. I was completely unnerved as it was apparent that I was asking for something out of the ordinary.

While I awaited the pasta asciutta trappenese, I drank cool pinot grigio wine produced in the mountains just outside of Venice and noted the endless platters of seafood, all very fresh and fragrant, coming out of the kitchen. I began to reconsider my order. Perhaps I should have a fish, I thought. Dorato. No, calamari!

But then the waiter finally appeared with a plate heaped with great steaming mounds of fragrant pasta. Not a serving but a platter of pasta that would satisfy a large Italian family. The scent of fresh basil wooed me, as did the fragrance of garlic, and I could see bits of deliberately overripened tomatoes that give such sauces their richness. The rest was simply redolent of all the scents that produce food lust.

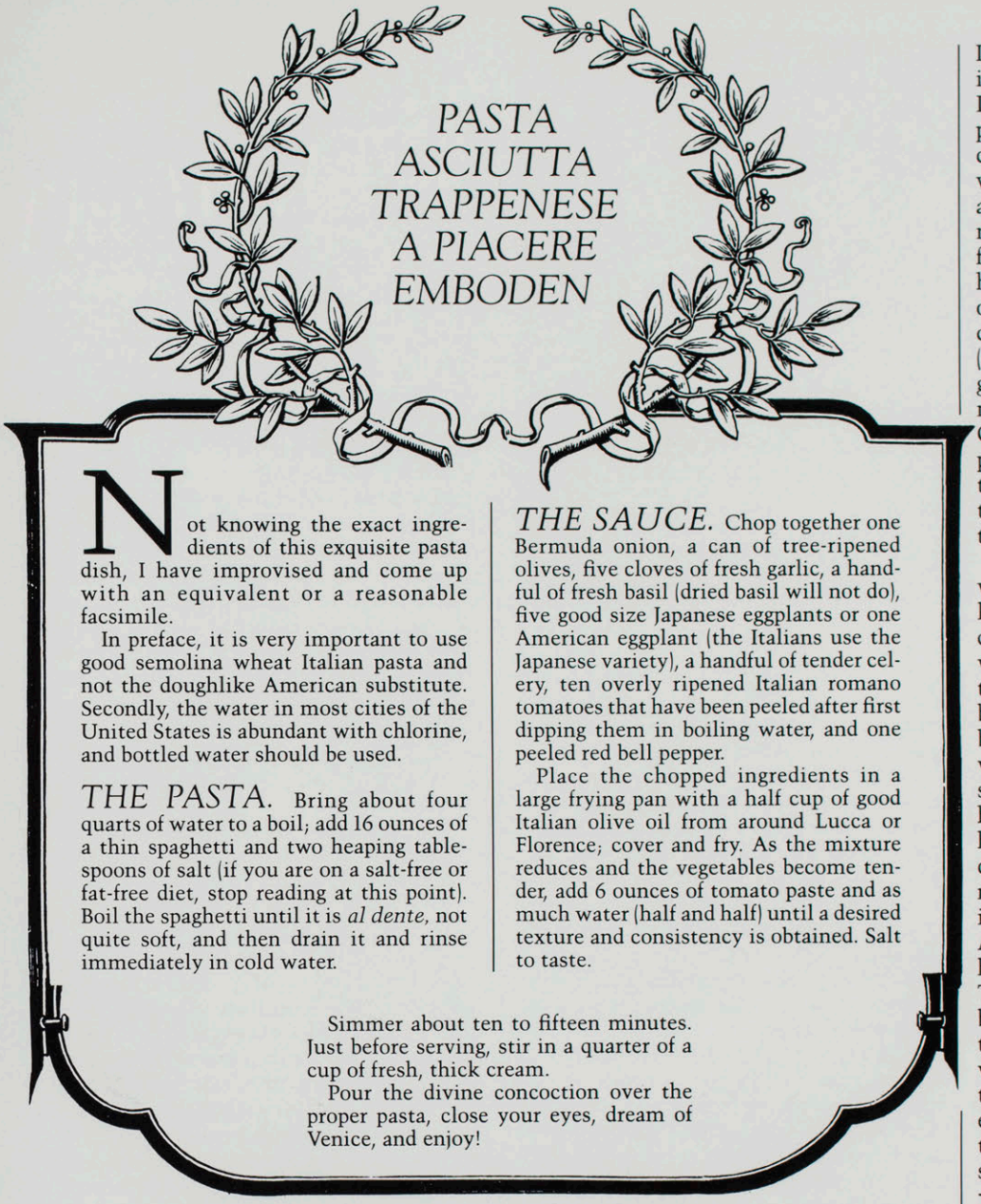
I thought that I might make only a slight incursion into the grand dish before me, but within half an hour it had all disappeared. What was the elusive matrix of this divine concoction? Perhaps I should repair to a Trappist monastery if this was indeed a "pasta trappenese."

Forgetting the fish and foreswearing any dessert, I returned to Legatoria Piazzei and found Signora Scopini slicing paper with her ivory knife. She did not look up but went on cutting slowly as she pronounced, "You like it." It was not a question but rather a statement of certainty and satisfaction. "What is in it?" I asked timorously. Signora Scopini smiled coyly. "Ask the chef. She will not tell you." This was not what I wanted to hear, for I had visions of returning to Los Angeles to recreate the fantasy and amaze my friends. The Signora relented. "All right, my dear," she said. "It's made of madapples." "Madapples!" I murmured. "What in the world are madapples?" Signora Scopini sniffed, "And you are supposed to be a botanist! It's *melanzana.*"

This Italian word made more sense to me than the English counterpart. A Latin binomial, *Solanum melongena,* came to mind, and I tried to salvage my professional reputation by mentioning it casually. "My dictionary says 'madapples,'" the lady insisted. "Now don't bother me further. I have a new countess to satisfy, and she is going to be as much trouble as you." With a wry smile she brushed me out of her elegant paper nest.

I returned to the Pensione Accademia contemplating the words of Rossini upon his premature retirement: "I shall spend the rest of my life eating and digesting." That was then my goal as well, but I would have endless days of a Trappistine diet of madapple pasta. Not the sad, soggy vegetable of my youth, flopping about in oil like some limp flounder, but the fragrant eggplant of Trattoria Ignazio, perfumed by garlic and basil.

I returned to California determined to look into the history of this curious black berry known as the madapple or eggplant. I found that the Italian *melanzana* is derived from the Latin name *mala insana,* literally the apple that causes insanity. The venerable botanist Fuchsius used this very characterization in his *De historia stirpium* of 1542, and it continued to be used as the most prevalent name until at least 1616. It is not too surprising, for the genus *Solanum,* in which this plant is properly placed, is in a family (Solanaceae), that contains alkaloid-producing members, many of which are toxic. The name *Solanum* is derived from *solamen,* which means sedating, and this is a property common to many of the over 2,000 species in the family. Even the enchanter's nightshade and the mandrake find their proper place in this assemblage. Many members have been viewed with suspicion if not fear. As late as the seventeenth century, we find the tomato referred to as the "love apple" or "inflamer of passions." This fruit, also a berry, was not accepted as a vegetable in the United States until 1710. The common white potato, *Solanum*



Not knowing the exact ingredients of this exquisite pasta dish, I have improvised and come up with an equivalent or a reasonable facsimile.

In preface, it is very important to use good semolina wheat Italian pasta and not the doughlike American substitute. Secondly, the water in most cities of the United States is abundant with chlorine, and bottled water should be used.

THE PASTA. Bring about four quarts of water to a boil; add 16 ounces of a thin spaghetti and two heaping tablespoons of salt (if you are on a salt-free or fat-free diet, stop reading at this point). Boil the spaghetti until it is *al dente*, not quite soft, and then drain it and rinse immediately in cold water.

THE SAUCE. Chop together one Bermuda onion, a can of tree-ripened olives, five cloves of fresh garlic, a handful of fresh basil (dried basil will not do), five good size Japanese eggplants or one American eggplant (the Italians use the Japanese variety), a handful of tender celery, ten overly ripened Italian romano tomatoes that have been peeled after first dipping them in boiling water, and one peeled red bell pepper.

Place the chopped ingredients in a large frying pan with a half cup of good Italian olive oil from around Lucca or Florence; cover and fry. As the mixture reduces and the vegetables become tender, add 6 ounces of tomato paste and as much water (half and half) until a desired texture and consistency is obtained. Salt to taste.

Simmer about ten to fifteen minutes. Just before serving, stir in a quarter of a cup of fresh, thick cream.

Pour the divine concoction over the proper pasta, close your eyes, dream of Venice, and enjoy!

tuberosum, becomes toxic when it is exposed to the sun. With the appearance of chlorophyll and green coloration, tropane alkaloids are synthesized by the potato. One of these, solanine, is responsible for numerous poisonings, which most people will ascribe to tainted meat or almost any other source.

Aubergine, guinea squash, insane apple, melanzane, eggplant, madapple, Jew's apple, and black Pekin were recorded by the botanist-explorer Edward Sturtevant in 1919 as being popular names for this fruit. By that time the fruit had become known throughout much of the world and was widely cultivated in the Americas. Early forms of the fruit were most often egg-shaped and hence the names guinea squash or, in England, Swanne's egge.

Although the giant purple variety and the slender, elongated form (variety *serpentinum*) are most familiar in Europe and America, there are numerous other colors and forms of eggplants. In 1616 the herbalist Dodonaeus compared the fruit to an egg; in 1686 the English naturalist John Ray stated that the berry was similar to a cucumber and curved like a long gourd. Only in 1719 did the first accounts of a large pear-shaped fruit comparable to that known today appear.

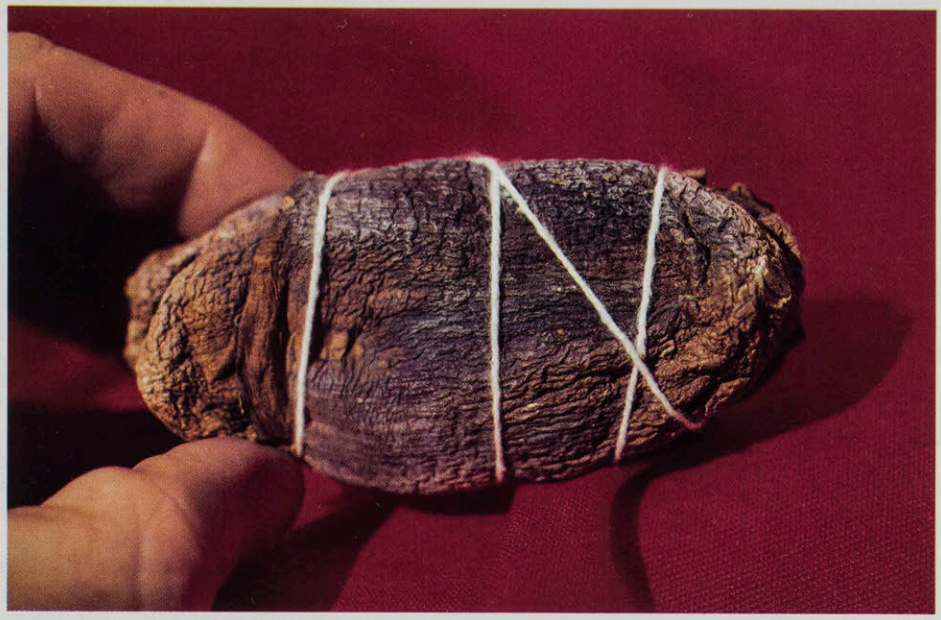
Of the many descriptions, that of John Gerard in his commentaries of 1597 is perhaps the most amusing if not edifying. Because of the wicked properties of the berry, he wrote, "it is therefore better to esteem this plant and have it in the garden for your pleasure and the rareness thereof, than for any virtue of good qualities yet knowne." Gerard regarded the fruit as poisonous and compared it to two noxious and toxic plants, the henbane *(Hyoscyamus niger)* and the greater nightshade (most probably *Solanum nigrum*).

John Parkinson wrote in his herbal of 1640 that the plant appeared to him to be harmless, but he felt compelled to cite earlier authorities, who had stated that these terrible fruits "engender Melancholly, the Leprosie, Cancers, the Piles, Imposumes, the Headache, and a stinking breath, breed constructions in the Liver and Spleene, and change the complection into a foule blacke and yellow colour, unlesse they be boyled in vinegar." Of course, none of these bizarre assertions has ever been verified, and we might be tempted to applaud Parkinson for his statement that "none have been harmed by eating this fruit." But he went on to state that in Italy and other hot countries where the fruits mature well (they do not thrive in the overcast English summers) "they doe eate them with more desire and pleasure than we do Cowcumbers." He compared the eggplant with the English cucumber because the latter was regarded as a refrigerant that ameliorated the passions whereas the eggplant "invites to Venery."

Were it not for the belief that the fruit was an aphrodisiac, it might never have known so great a popularity. But aphrodisiacs were especially being sought in western Europe at the time to counter the supposed effects of coffee, which had been recently introduced there and was believed responsible for the loss of men's virility. Some men explained their absent passion to their wives as due to heated discussions of politics in coffee houses. More likely they were in ardent consort with their mistresses. There is no evidence that any man has suffered impotence as a result of drinking coffee. And conversely, no virility is known to have been restored by eating eggplant. The form of the fruit was seen by some to be testicular. And, according to the doctrine of signatures, each plant would reveal in its form the thing for which it was to be used. It is easy to account for the eggplant's association with venery when the widespread belief in this inaccurate system of analogies is taken into account.

Ethnobotanists have argued that the eggplant is either of Indian or African origin, or possibly Asian, but evidence is scanty. The fact that it will hybridize with another species in the family, *Solanum incanum*, is of little help because this wild plant flourishes in both India and Africa. Small, seemingly wild forms of the eggplant are found in several parts of India, but these may represent atavistic tendencies in the plant rather than truly wild forms of it.

The Arab physician Ebn Baithar wrote of the eggplant in the thirteenth century, stating that it was known to another physician in the Arab world, Rhases, as early as the ninth century. The philosopher and scientist Albertus Magnus recorded it as being in Europe in the thirteenth century, and Ibn-al-awarm, a Spanish Moor of the twelfth century, described four different varieties of eggplant and noted that six kinds were known in the agriculture of Nabataea, the Arab kingdom that prevailed in Palestine between 300 B.C. and 100 A.D.



William A. Emboden

A fascicle of dried, pressed eggplants—one dozen in all!

The Arabian physician Avicenna, who lived and worked about 959 A.D., knew the plant under the name *badingan.* It was mentioned in the *Ts'i min yao shu,* a Chinese treatise on agriculture of the fifteenth century. In his *Natural and Moral History of the Indies,* the Spanish explorer Acosta [1590] notes that the fruit was taken from Spain to America under the name *berengenas* ("apples of love"), a name not too far removed from *belingela,* the Brazilian term for the plant used by the explorer Piso in 1658.

The accounts of early European physicians and botanists reveal that the first eggplants to come to Europe were small and egg-shaped. Fuchsius in 1542 mentioned both the purple and the yellow fruits as did Tragus in 1552 when he described the plant being brought from Naples to Germany. Lyte in 1586 wrote of one kind that is purple and another that is pale or white. In 1587 Dalechampius described three known forms and as many colors; long, pear-shaped, and rounded in the colors purple, yellow, and ashen. All subsequent accounts mention the various colors and forms, although there seems to have been a growing preference in Europe for the larger purple kinds, whereas the white and yellow egg-shaped fruits were grown primarily for ornament. In Cochin China (now part of South Vietnam) a variegated fruit was developed at some point. The colors of yellow and white now are found only in the oval forms and not in the long, the round, or the pear-shaped varieties.

Ch'ieh and *Lo-su* are both Chinese names for the fruit of the eggplant; the latter refers to the similarity between the berry and a ball of cheese. It is also called Kulun melon *(K'un-lun-kua)* in China and is found there in all of the forms and colors familiar to the western world. As a food it is viewed with suspicion, but it is eaten none the less. During the summer many fruits are dried into prunelike balls to be used when fresh fruits are not available. The dried eggplant is easily rehydrated in water.

From the above account it is apparent that the eggplant was of considerable interest to a number of men who counted themselves physicians or herbalists. The plant has a history in medicine as well as in the agriculture of comestibles and esculents. It was mentioned in thirteenth century Arabic medical manuscripts, and this may have been the source of its introduction into Europe as early as the fourteenth century.

The eggplant's medical reputation in Europe today, as in earlier times, is as a promoter of bile excretion into the upper portion of the small intestine. This effect is attributed to various substances in the plant, including solanine, anthocyanins (the pigments of the plant), and some vitamins. Young eggplants contain more solanine than older fruits and may have a toxic effect on the blood (red blood cells are split in the presence of solanine); thorough cooking results in the breakdown of solanine, most of which is concentrated near the rind of the berry. The fruit is also reputed to reduce levels of cholesterol and to function as a diuretic. These latter attributes are in marked contrast to those presented by sixteenth-century herbalists.

Chinese herbalist-physicians warn that overindulgence in eggplants may lead to digestive complaints and even injure the uterus. The eggplant is considered a fever reducer by the Chinese and is mixed with vinegar and applied to abcesses as a poultice. Mothers who suffer from cracked nipples after nursing use the fruits as an astringent. The peduncle, the small stalk that supports the flower and subsequently the fruit, is reduced to ash and taken internally for intestinal hemorrhaging, to relieve piles, and for toothache. The root, dried stems, and leaves are boiled, and the resulting liquid is then cooled and used on open sores and pustules and taken internally for bladder hemorrhage and flux.

The popularity of the eggplant in Provence, France, may in part be related to the frequency of liver and bile complaints among the residents of the area. These conditions are very likely associated with excessive consumption of red wines. Whether or not aubergine is able to alleviate complaints resulting from liver malfunction and bile flow is debatable, but the classic eggplant dishes of Provence should not be missed by any traveler in southern France.

In the Americas, Mexico has adopted *Solanum melongena* as a medicant as well as a food under the name *berenjena.* The flowers are made into an alcoholic tincture, in the ratio of one part crushed flowers to five parts alcohol; the tincture is considered to be a fine agent for reducing high blood pressure as well as a hypnotic when concentrated. A tea made of the flowers is used as a mild tranquilizer and is also considered useful in treating hardening of the arteries. These uses are derived from popular folk medicine and remain to be substantiated by medical studies.

The popularity of numerous varieties of eggplant is increasing. The vegetable is commonly found in diverse restaurants—being baked, fried, boiled in oil, offered as small pickles and caponata, or added to curries, and sometimes to souffles. The modes of preparation are limitless. The popularity of the fruit must be based on its taste, for it has little food value apart from a few vitamins and several important minerals; it is 93 percent water, and its carbohydrate, lipid, and protein content is negligible.

Given the low food value of the eggplant, a reinvestigation of the Chinese, French, and Mexican traditions of using various parts of the plant as medicines might be in order. Many new remedies are being derived from early ethnobotanical lore. The enticing madapple may be of greater importance than is now generally known.

The madapple may never be formally recognized in the annals of medicine, but I will return to Venice for my madapple pasta, whose exact composition still remains very much a mystery. And perhaps what that somewhat disreputable barber-surgeon John Gerard said of such plants in 1597 is applicable today: "The delight is great, but the use greater, and joyned often with necessitie."

William Emboden, Professor of Botany at California State University, Northridge, is a Research Associate in botany at the Natural History Museum of Los Angeles, and a Research Fellow at The Botanical Museum of Harvard University. He is a bon vivant, a hedonist, and believes that living well is its own reward.

The World of Marine Micromollusks

by JAMES H. McLEAN

Seashells have always had great appeal to collectors of natural objects, as they are unsurpassed in the variety and beauty of their form and color. Some shells are large enough to use as trumpets or punch bowls. However, many species of shelled mollusks are quite small, some no larger than grains of sand. There is, in fact, an entire world of seashells that the observer can only enter with the help of a binocular microscope. With magnification of five to twenty times, one can discover the many different families of minute or small-shelled mollusks known as micromollusks or microshells. All are intricate in form and color; some resemble the more familiar, larger seashells of tropical and temperate seas, but others are entirely different. One finds some species that are full grown at less than a millimeter in maximum size and many others that are mature at sizes up to 6 millimeters (one-quarter of an inch) in length.*

A close look at coarse beach sand may reveal the presence of tiny shells, but this is not the best place to look for them because such specimens are likely to be so abraded that the sculpture, or surface detail, is lost. Occasionally, good recently dead microshells are found on beaches at the drift line, where a narrow deposit of shells can be left by the uppermost reach of the preceding high tide. The best place to look for microshells, and the only place to find them in perfect condition, is where they live. The most prolific habitats are rocky places where algal growth is thick.

You can get a good introductory look at microshells by taking a handful of seaweed off the rocks, either at low tide or by reaching beneath the water as deeply as possible. The algae should be shaken in a small basin of seawater. Many tiny snails may drop off the seaweed into the basin, from which they can be transferred into a small jar. This method has the advantage of isolating living specimens away from sand and gravel particles. You can then examine the living specimens in a dish of seawater under a microscope. The snails move with great rapidity and are fascinating to observe. Unfortunately, you will collect only some of the microshells living in the vicinity with this method, as not all of the species live on the fronds of algae.

*Shells between one-quarter inch to one inch in length are small but are too large to be called microshells.

Page 25: Unsorted microshells after extraction from grunge sample taken by diving at a depth of 70 feet at Punta San Pablo, Baja California, Mexico. The long slender shell is 6 mm in length.

A greater variety of microshells can be collected by scooping the surface layer of sand or gravel from the bottom of a tide pool, especially the sand that accumulates under rocks. Another method is to yank surfgrass from the seafloor and shake the roots in a bucket of seawater. You can take an even larger variety of species if you are a scuba diver. On rocky bottoms, you can fill a small cloth sack with the gravel that has accumulated in crevices or under rocks. If you are diving above sandy bottoms, the most effective way to collect the microshells is to sift the sand underwater, using a fine-meshed hand net; the net will let fine sand particles pass through while retaining the larger particles as well as all the shells that were living in the sand.

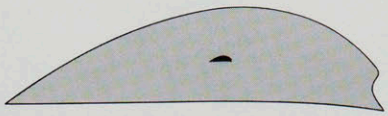
An unsorted concentration of shell specimens in sand and gravel residue is appropriately known as "grunge" (this word, which brings gravel and mud to mind, is commonly used by collectors, although it is not yet to be found in the dictionary). Grunge samples are rich sources of small shells, but a certain amount of effort is required to separate the shells from the residue—a quart of grunge, which may yield hundreds of small specimens, can take hours to sort. If only the shells (rather than the living animals) are to be studied, it is easiest to handle the sample after it has been washed in fresh water and dried on paper towels (the specimens are so small that there is no problem with odor, but soaking the sample in alcohol prior to drying is one way to make it dry rapidly and completely prevent decay).

Once dried, the sample should be screened into different size fractions, which makes it easier to examine. A set of screens of different sizes can be made from small pieces of hardware cloth and window screening for this purpose; screens of graduated mesh size are also available from geological supply companies. After the dried sample has been screened, the larger fractions can be picked for shells by eye, and the intermediate size can be sorted with the help of a large magnifying glass mounted on a stand; the smallest sizes of the screened fraction have to be examined under a dissecting microscope. Shells of each size can be extracted with fine forceps that are available from biological or geological suppliers. The shells should then be sorted by species and placed in small vials or plastic boxes. In the Malacology Section of the Natural History Museum, we store microshells in micropaleontological slide mounts made of thick cardboard and topped with plastic cover slips; these are also available from biological or geological suppliers. Locality information is written on the slide mounts.

(Continued on page 30)

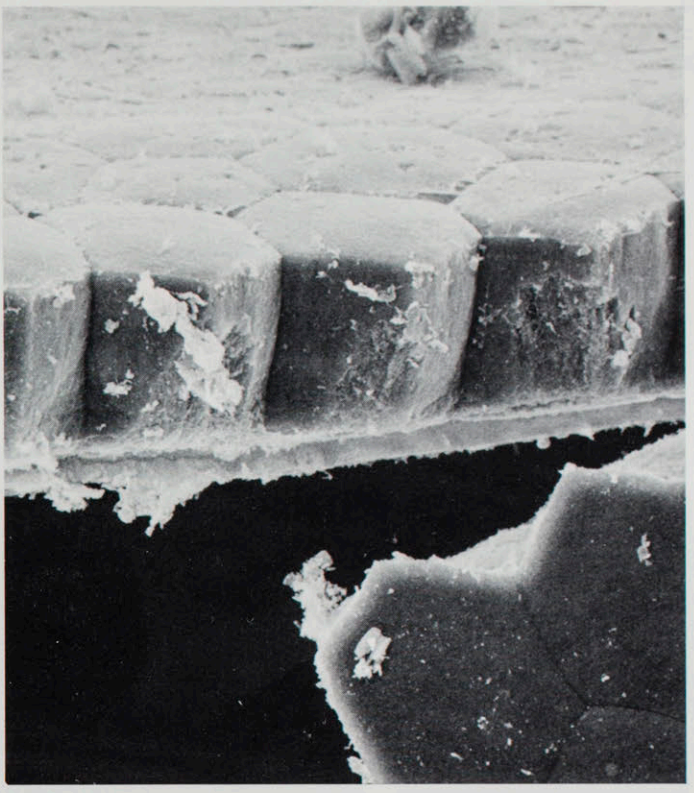
USE OF THE SCANNING ELECTRON MICROSCOPE (SEM) IN MALACOLOGICAL RESEARCH

In 1979 a remarkable mollusk, a species of the "living fossil" group of monoplacophorans, *Vema hyalina*, was described by Dr. McLean in the museum's Contributions in Science series (number 307). The species lives at the edge of the continental shelf in southern California. Other members of this group had been known only from abyssal depths. *Vema hyalina* is also a true micromollusk, for the maximum length was only 2.3 mm. The SEM played an important part in revealing the fine structure of this microscopic species, enabling a close look at the soft body of the animal, the texture of the shell, and the radula ribbon, or teeth, of the mollusk.



Outline view of lateral profile of the shell of *Vema hyalina*, anterior end at right, compared to the actual size (2.3 mm in length) of the specimen (the small figure in the center).

Macrophotograph of preserved specimen attached to shell; the head is toward the top; the foot in the center is surrounded by six pairs of forked gills.



SEM photograph of broken edge of shell at a magnification of 1100 times. The shell structure is shown to consist of hexagonal prisms.

SEM photograph of head region of critical-point dried specimen at a magnification of 190 times, showing the radula in the open mouth.

SEM closeup of open mouth of same specimen showing the row of teeth on the radular ribbon. Magnification 900 times. The outermost tooth in the row is broad and has a comblike fringe.

Right: Moelleria costulata, *two specimens, diameter 1.7 mm. Seldovia, Alaska.*

Page 29 left: Solariella peramabilis, *two specimens, juvenile shells, 4.5 mm. Off Catalina Island, California.*

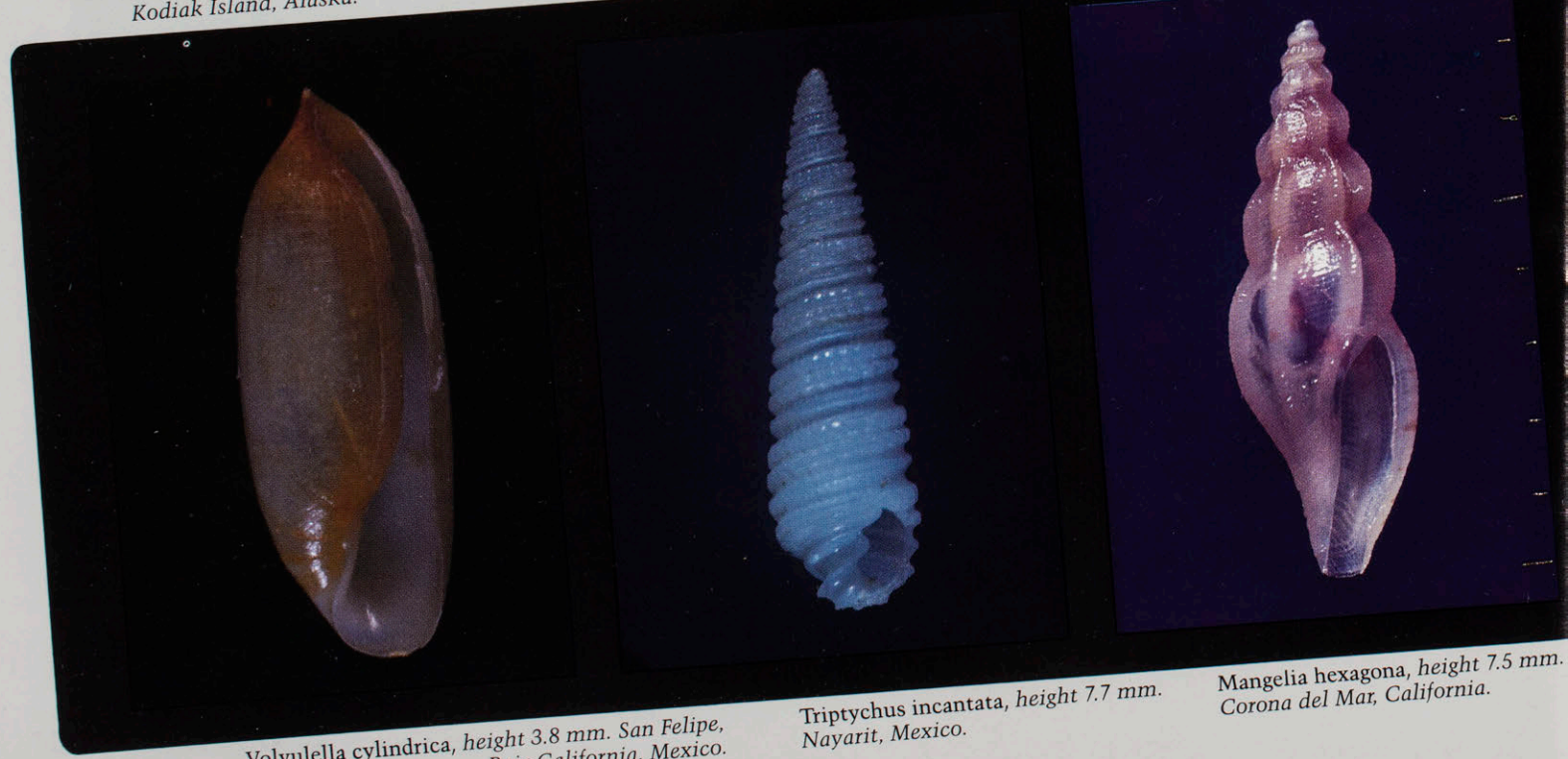
Page 29 center: Arene olivacea, *diameter 3.2 mm. Costa Rica.*

Page 29 right: Miralabrum planospiratum, *three views of same shell, diameter 4.8 mm. Guaymas, Mexico.*

Balcis columbiana, *height 7.3 mm. Kodiak Island, Alaska.*

Clathromangelia fuscoligata, *height 8.0 mm. San Pedro, California.*

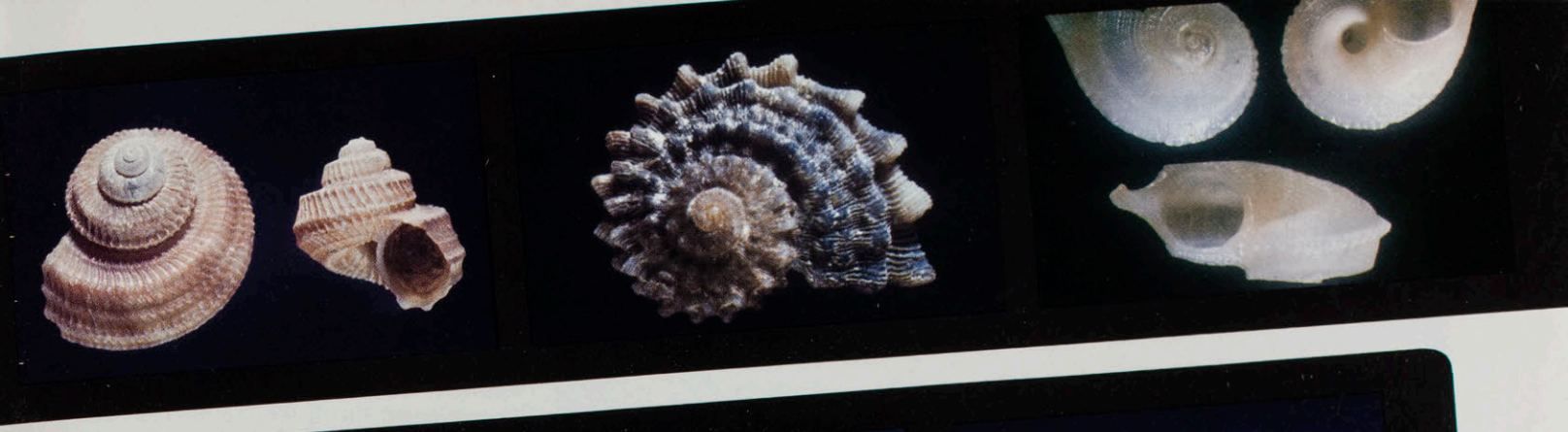
Ividella navisa, *height 3.2 mm. Santa Rosalia, Baja California, Mexico.*



Volvulella cylindrica, *height 3.8 mm. San Felipe, Baja California, Mexico.*

Triptychus incantata, *height 7.7 mm. Nayarit, Mexico.*

Mangelia hexagona, *height 7.5 mm. Corona del Mar, California.*



Triphora vanduzeei, *height 6.0 mm. Pulmo, Baja California, Mexico.*

Nodiscala spongiosa, *height 8.0 mm. Guaymas, Mexico.*

Microdaphne trichodes, *height 4.0 mm. Santa Rosalia, Baja California, Mexico.*

Rissoina signae, *height 3.2 mm. Nayarit, Mexico.*

Volvarina taeniolata, *height 8.5 mm. San Pedro, California.*

Eulima *sp., height 3.3 mm. Bahia Herradura, Costa Rica.*

(Continued from page 26)

The number of species of microshells that can be found in one place is much greater in tropical waters than in temperate waters. In such places as the Gulf of California, the Philippines, and the Great Barrier Reef in Australia, it is not unusual to find 200, 300, or even 400 different species in one sample. (Although 400 species from one locality may seem like a large number, there are some 50,000 species of mollusks, and large numbers of species occurring at any one place are therefore not unusual.) At a depth of 100 feet, the water may be cooler, and the species diversity and composition often changes; thus many species are found only at or below this depth. Again, the variety of species to be found at these depths is greatest in tropical regions. Here in southern California, a scuba diver who takes a grunge sample at any of the Channel Islands can easily collect hundreds of small specimens, representing as many as 100 different species.

Although many guide books with colored or black and white figures of numerous shells are available to shell collectors, there are no general books that exclusively treat microshells. Indeed, there are only two books treating entire faunas that even attempt to illustrate all of the micromollusks from one region: E. A. Kay's *Hawaiian Marine Shells* (Bishop Museum Press, Honolulu, 1979) and A. W. B. Powell's *New Zealand Mollusca* (Collins, Auckland, 1979). *Marine Shells of Southern California,* which I wrote in 1969 and revised in 1978, does include most of the Micromollusks that can be found by shore collectors and scuba divers on rocky bottoms in southern California. [Editor's note: this book was published by the museum and is available in the Book Shop.]

There are four main groups of shelled marine mollusks: the Gastropoda or snails, the Bivalvia or clams, the Scaphopoda or tusk shells, and the Polyplacophora or chitons. The great majority of both small- and large-shelled marine mollusks are gastropods; there are about three times as many species of gastropods as there are of bivalves. The chitons and scaphopods, among which there are no microshells, are relatively few in number. As in all other kinds of animals, each family of marine mollusks has a consistent size range. Thus, entire families may be classified as micromollusks. These families have feeding and reproductive strategies that are as varied as those of their larger relatives.

Juvenile shells (early growth stages) of large-shelled mollusks are also within the size range (up to 6 mm in length) of micromollusks. However, juvenile shells of the large species may be distinguished from those of micromollusks in having a relatively large early whorl (protoconch) of the shell. The early shell also provides clues as to the kind of embryonic development followed in gastropods. Whether the species are large or small, there are two main kinds of embryonic development: some develop directly into miniatures of the adult (after a brief larval stage, either free-swimming or taking place within the confines of egg capsules), others have a long free-swimming larval stage called a veliger. In species that develop directly, the protoconch has only one turn (whorl) before the appearance of shell sculpture like that of the mature shell. In species that have a planktonic veliger stage, the protoconch is followed by two or three whorls having sculpture that is entirely different from that of the adult snail. This early sculpture is formed during the planktonic stage, when the shell must be lighter to stay suspended in the water. The transition to adult shell sculpture, which is readily seen in the shell, marks the change from planktonic life to a life on the sea floor. Both embryonic strategies are found among the microgastropods.

Here at the Natural History Museum, the staff members in the Malacology Section have particularly concentrated on building our collection of micromollusks. Grunge samples are collected from all localities that we visit on our field trips and expeditions. The processing of the material—the picking and sorting of specimens from the grunge—has been done primarily by volunteers, who each devote a day a week to the project. Over the last 20 years, thousands upon thousands of microshells from many places around the world have been added to the research collection. This collection is a major resource, one that is used by specialists from other museums who are studying the small shells in an attempt to learn more about their classification and evolution.

One can generally assign a marine shell species to a genus on the basis of shell characters (features such as absolute size, color pattern, form of sculpture, etc.), but the family classification is based upon anatomical differences in the soft bodies, including internal structure and such external features as the number and placement of the sensory tentacles. Most of the large-shelled marine species are now well known, but there are many smaller species discovered and named each year and untold numbers from the more remote regions of the world yet to be discovered.

The study of micromollusks has always been difficult because of their small size. In recent years, however, a powerful new tool—the scanning electron microscope (SEM)—has made their study more rewarding. Small specimens can be photographed with an almost limitless depth of field, and small areas on the shells can be enlarged. Microsculpture on protoconchs can be examined, revealing detail that is barely visible under the dissecting microscope. Additionally, the soft bodies of these mollusks can be examined with SEM after the specimens are rendered rigid by critical-point drying, which removes all water from the tissues. Viewed with SEM, the microstructure of sense organs on the surface of the animal can be even more intricate than the fine sculpture of the shells.

The feeding device of snails, and other mollusks except bivalves, is the radula, a rasplike structure that bears rows of microscopic teeth. The configurations of radular teeth are used in assigning species to their correct family. The SEM has greatly facilitated study of the extremely small radulae of microgastropods. Some of the applications of the SEM to research on micromollusks are shown here in a series of illustrations of the recently described monoplacophoran limpet *Vema hyalina.*

Many groups of minute mollusks continue to be known only by their shells in museum collections. The shells of different species of micromollusks often appear to be quite similar, but the anatomies differ enough to place them in quite unrelated families. Thus the species in these groups need to be examined alive before we can fully understand their relationships. Many questions remain to be answered, and our quest for micromollusks from around the world continues.

Dr. McLean is Curator of the Malacology Section of the Natural History Museum. His research focuses on the taxonomy and biogeography of marine mollusks, particularly gastropods, from the eastern Pacific.

The color photographs of single shells illustrating this article were taken by Bertram C. Draper, a museum volunteer who has made a specialty of the macrophotography of minute shells. The SEM photos were made by M. Patricia Morse of Northeastern University.

(Continued from page 2)

MUSEUM FOUNDATION OFFICER APPOINTED

The museum welcomes Dr. Kenneth J. Daponte to the newly created position of Executive Vice President of the Natural History Museum Foundation. Dr. Daponte, formerly the Vice President for University Relations at Loyola-Marymount College, will serve as the Foundation's chief operating officer. In that role, he will direct the planning, organization, and implementation of development and public relations efforts on behalf of the museum's Foundation and its Board of Trustees.

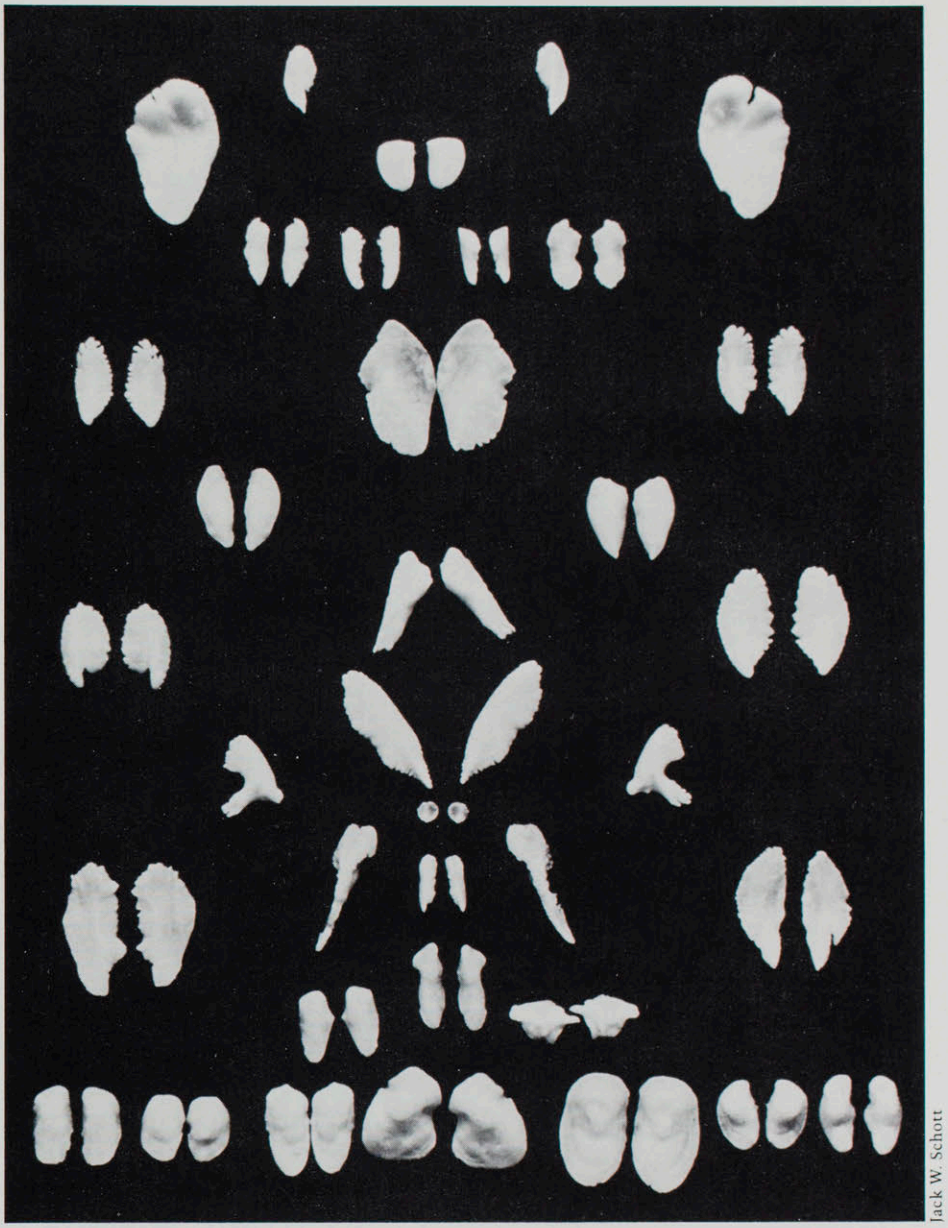
NEW GRANT TO INVERTEBRATE PALEONTOLOGY

The National Science Foundation has announced the award of a grant of $44,758 to the museum's Foundation for the curation and storage of the invertebrate fossil collection recently transferred to the museum from the California Institute of Technology (see TERRA, Jan./Feb. 84). The project, which includes the purchase of sixty new storage cabinets and the hiring of an assistant for one year, is under the direction of Dr. Edward C. Wilson, Curator of Invertebrate Paleontology.

ICHTHYOLOGY GAINS OUTSTANDING OTOLITH COLLECTION

With the recent acquisition of the extensive holdings of the late John E. Fitch, long-time Research Associate and preeminent world expert on the study of otoliths, the Ichthyology Section became the custodian of the world's largest, most comprehensive, and most authoritatively identified collection of these small fish earstones. We now have more than 100,000 pairs of otoliths from existing fishes representing more than 5,000 different species (more than 25 percent of all the various kinds of living fishes) and about a half million otoliths representing more than 1,000 fossil species.

What is an otolith, and what good is it? Otoliths are generally small, sometimes microscopic calcium carbonate concretion-like structures found in fluid-filled chambers in the semicircular canals of fishes. Most fishes have three canals and three otoliths, one of which is larger than the other two, on each side of the head. These structures help a fish to maintain its sense of balance. But why do we store them in a museum? For many species of fishes the shape of its otolith is quite unique, almost like a fingerprint or a signature for the species. Otoliths are relatively resistant to digestive juices and seem to accumulate in the stomachs of sharks, seals, sea lions, and other fish-eating predators; an expert can compare stomach contents with otoliths of known provenance and tell what the predators have been eating as well as the length and weight of the prey. Otoliths are also sifted from middens, sites formerly inhabited by prehistoric peoples, and can serve as clues to fishes that were caught; from this information, deductions can be made about how far from shore and at what depths early peoples were able to fish. The occurrence of otoliths in dated middens or dated sediment cores taken from the ocean floor is used to estimate past ocean temperatures based on the occurrence of warm-water or cold-water species.



Jack W. Schott

A display of otoliths showing representative types from teleostean fishes including herrings, cod fishes, sea basses, and drums.

For some kinds of fishes, degree of similarity in the shapes of otoliths from different species has helped to indicate groups of related species and has thus been of aid to the systematist or classifier.

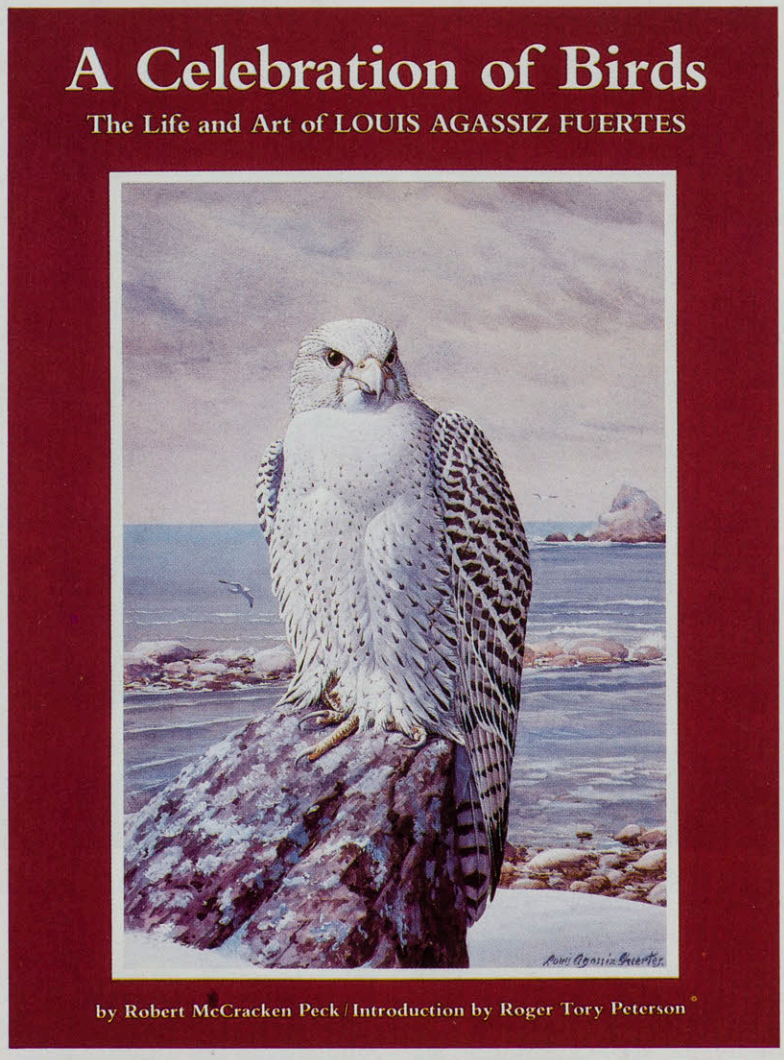
Finally, otoliths grow from the outside, and a cross section or a thin section through one will show concentric layers; tiny ones recently discovered are indicators of daily growth whereas larger kinds may indicate seasonal or yearly growth. Furthermore, otolith growth is proportional to body length; hence, we can learn not only the age of a fish, but also its size at a given age.

We anticipate high use being made of this unique resource, by both museum staff and scientists from other institutions.

IN THE *NEW* MUSEUM BOOK STORE...

A CELEBRATION OF BIRDS:

The Life and Art of Louis Agassiz Fuertes


A Celebration of Birds
The Life and Art of LOUIS AGASSIZ FUERTES
by Robert McCracken Peck / Introduction by Roger Tory Peterson

The American artist, Louis Agassiz Fuertes (1874–1927), is widely acclaimed for his ability to capture the true characteristics of birds in their natural habitats. A CELEBRATION OF BIRDS is a comprehensive book about Fuertes featuring text that catalogs his work as an artist and naturalist, as well as beautiful color reproductions of his paintings. A CELEBRATION OF BIRDS is offered in conjunction with the current exhibition of Fuertes' work, on view at the museum from July 3 through August 19, 1984.

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